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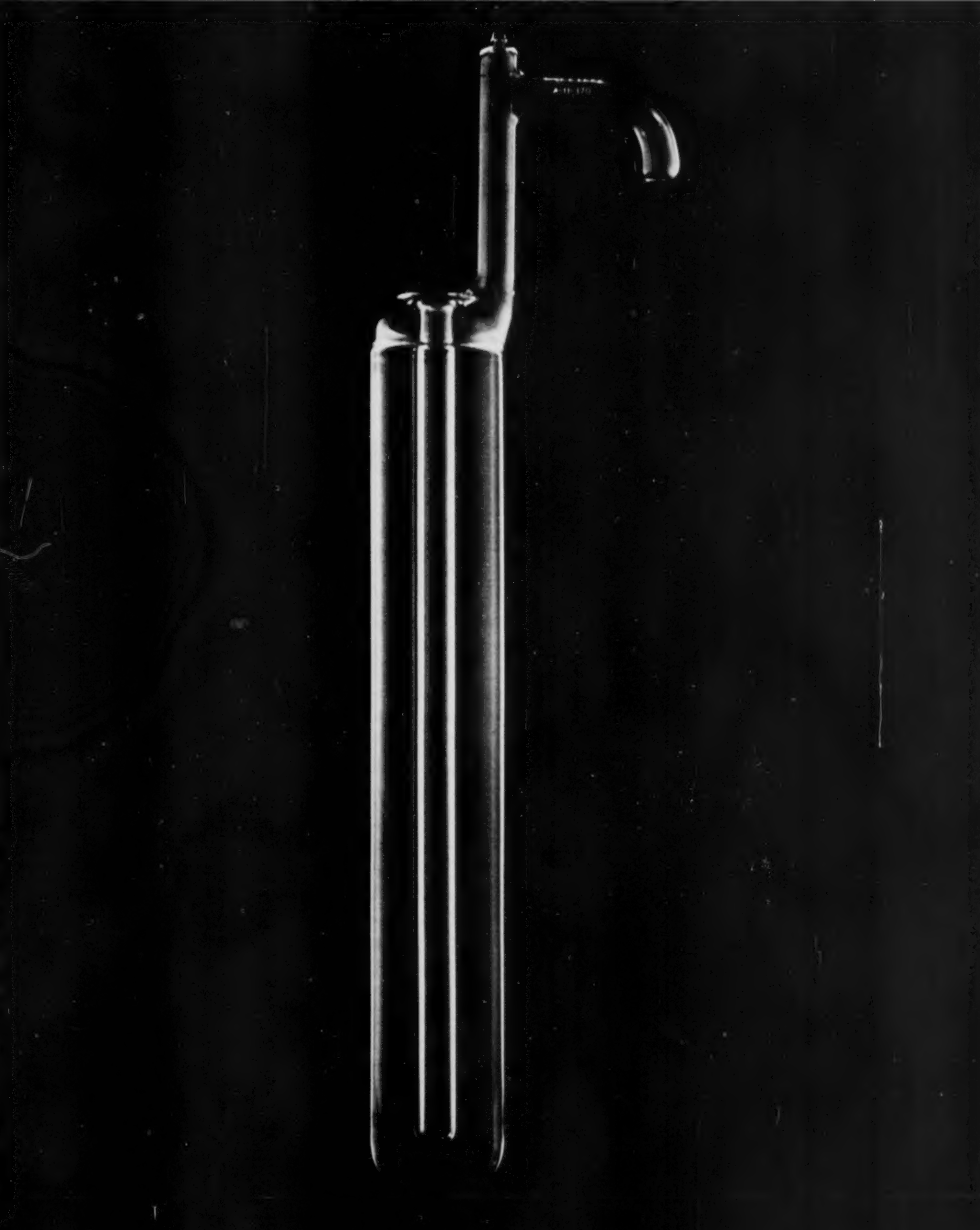
## NATIONAL BUREAU OF STANDARDS

# Technical News Bulletin





**UNITED STATES DEPARTMENT OF COMMERCE**

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# Technical News Bulletin

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*COVER: The thermodynamic or Kelvin scale of temperature used in the International System of Units (SI) has its origin or zero point at absolute zero and has a fixed point at the triple point of water, defined as 273.16 kelvins. The triple point cell shown on the cover, an evacuated glass cylinder filled with pure water, defines this fixed point. When the cell is cooled until a mantle of ice forms around the reentrant well, the temperature at the interface of solid, liquid, and vapor is 273.16 K. For a discussion of the SI base units see page 64.*

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

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- The Institute for Materials Research
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The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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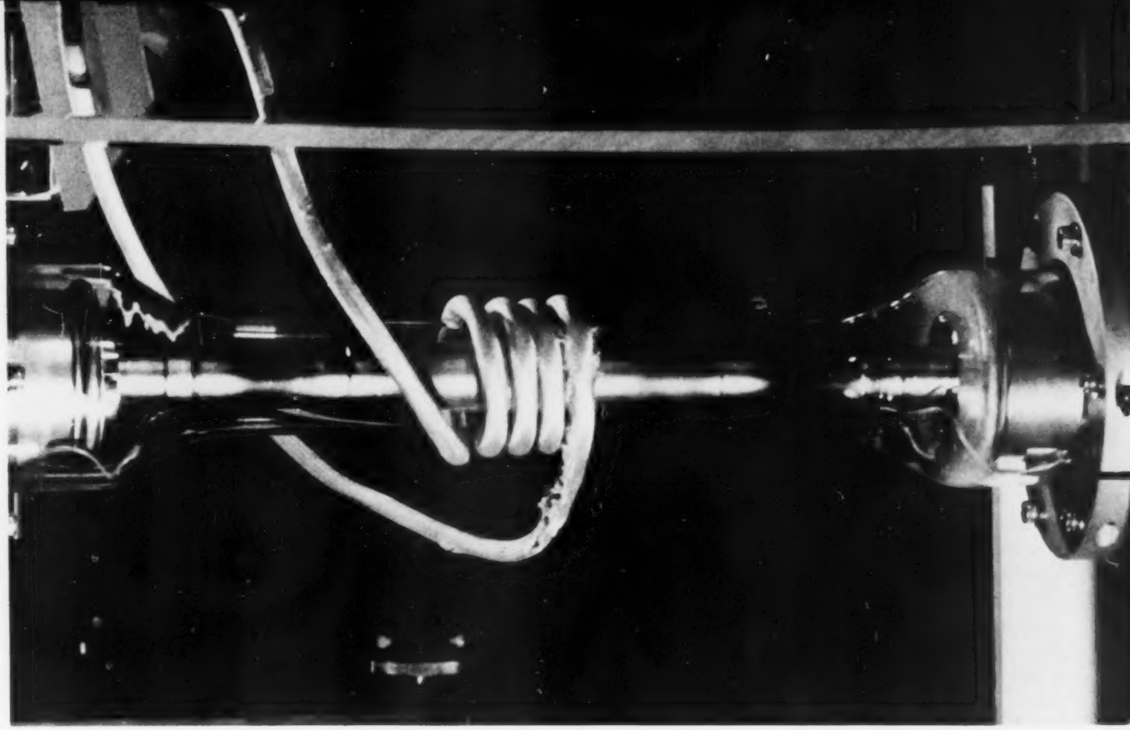

*The absorption spectrum of lithium has been investigated from 56 to 70 eV using the NBS synchrotron and the lithium heat pipe oven shown here. Lithium is vaporized in the stainless steel, horizontal pipe oven (center) enclosed within a quartz vacuum tube and heated by an rf coil wrapped around the system. The windows of the oven are enclosed within the solid cooling sections at either end.*

# LITHIUM VAPOR SPECTRA INVESTIGATED

PHYSICISTS AT THE BUREAU have, for the first time, observed and analyzed the spectrum of atomic lithium from 56 to 70 eV (or about 220 to 170 Å). Lithium was chosen for study as the simplest of the metals, the third simplest element, and the easiest for theoretical verification. But, because of its reactivity, it is one of the most difficult elements with which to work. David L. Ederer, Thomas B. Lucatorto, and Robert P. Madden of the Optical Physics Division overcame the problem and investigated the autoionization spectrum of lithium [1] by using a modified version of a heat pipe oven [2] developed at the NBS Boulder laboratories, and the NBS synchrotron.[3] Theoretical analyses [4] of the electronic excited states producing the observed resonance peaks were provided by Andrew W. Weiss and John W. Cooper, also of the Optical Physics Division, in collaboration with scientists from the University of Nebraska and Quantum Systems Inc.

The observation of a very strong absorption line at 210.5 Å may be of considerable importance to astronomers interested in the lithium concentration of the solar atmosphere. Present estimates of the lithium concentration are based on absorption measurements of the lithium resonance line at 6708 Å. The results are somewhat uncertain because close lying lines of iron prevent an accurate separation of the lithium contribution. It is presently felt that the absorption line at 210.5 Å will also be observable in the solar atmosphere and may enable astronomers to make a more accurate determination of the lithium density.

Another application of these measurements of the lithium uv spectrum in the vapor phase is the study of solid state effects in solid lithium and lithium halides. A comparison of the vapor spectra with the solid spectra will shed some light on the nature of crystalline and chemical forces. This work is just the beginning of a program to extend further the knowledge of the lithium spectrum and to investigate the spectra of other vaporized metals.

The apparatus used in these experiments includes the Bureau's 180 MeV electron synchrotron, a heat pipe oven, a grazing-incidence spectrograph, and a scanning monochromator. The synchrotron is the source of high intensity, far ultraviolet (uv) radiation. The uv radiation is generated in the forward direction by the acceleration of orbiting electrons and is extracted

*Continued on p. 72*

# SI Units

## *Philosophical Basis for the Base Units**

THE INTERNATIONAL SYSTEM OF UNITS has been defined in a publication** of the BIPM. The system is designed to provide a convenient, logical and internationally accepted way of expressing the results of physical measurement. The application of such an international system would seem to be desirable if one wishes to try to promote the exchange of data, goods, and services on an international scale, by eliminating ambiguity and misunderstanding of units. The NBS staff would clearly wish to cooperate in this endeavor, and is asked to use the SI Units, except where the intended long-range benefits would not accrue. Two areas of concern have been expressed. One we shall merely mention, the other we shall discuss in some detail. The first one relates to engineering practice, where the English system is often so deeply entrenched, that people fear the economic loss that could result through changing units. Forthcoming studies on metrication will speak to this issue; it is an extremely important one. The second relates to the use of the SI in certain areas of research in physics and usually ends up in a discussion of the nature of the Base Units: metre, kilogram, second, ampere, kelvin and candela—to which it is now proposed to add mole. It is this question that we wish to discuss.

Much of the concern expressed seems to stem from a misunderstanding that the Base Units, taken as a whole, are to be regarded as measures of quantities that in some sense represent unique, fundamental and "basic" conceptualizations of the physical world. This can clearly not be the case, since our concepts of the nature of the physical world are constantly evolving. Even from the viewpoint of presently held theories and widely accepted patterns of thinking, not all the Base Units can be regarded as being equally fundamental.

Perhaps if there had been defined primary units and secondary units instead of Base Units and Derived Units one would have been able to pursue a more logical course. The primary units would be those units whose realizations would be defined in such a way that would make these units independent of changes in other units. The secondary units would be those units whose realizations involve prior assignment of other units. As a consequence, a secondary unit is dependent upon changes in at least one primary unit. In this context, the metre, kilogram, second, kelvin, radian, and steradian would be the primary units. In the SI, the Base Units do not coincide with the above definition of primary units, and the Derived Units do not coincide with the above definition of secondary units.

If one tries to develop a more concise or compact definition for the term Base Unit than we already attempted to give, one ends up trying to attach deep meaning to a convention, which tends to be a fruitless occupation. At best one simply fails, and at worst one ends up by trying to squeeze an intellectual structure of great intrinsic richness and subtlety into a narrow preconceived groove, with obvious consequences. In the face of the situation, it seems that one is forced to be pragmatic. When one is dealing with a practical metrological system, perhaps this is the wiser course to follow. We could say that the SI units are what they are defined to be until some practical development makes some change preferable, and let it go at that. Indeed the official statement from *Special Publication 330, The*

*This statement was prepared by E. Ambler, Director of the NBS Institute of Basic Standards, for use within NBS. It is reproduced here for the benefit of readers of the Technical News Bulletin.

**Le Systeme International d'Unites (SI), available in translation as NBS Special Publication 330, SD C13.10:330, 50 cents.

*International System of Units (SI)*, reads as follows:

### "I. The three classes of SI units

SI units are divided into three classes:

base units,
derived units,
supplementary units.

From the scientific point of view division of SI units into these three classes is to a certain extent arbitrary, because it is not essential to the physics of the subject.

Nevertheless the General Conference, considering the advantages of a single, practical, worldwide system for international relations, for teaching and for scientific work, decided to base the International System on a choice of six well-defined units: the metre, the kilogram, the second, the ampere, the kelvin, and the candela (see II.1, page 3). These SI units are called *base units*.[2, 3]

The second class of SI units contains *derived units*, i.e., units which can be formed by combining base units according to the algebraic relations linking the corresponding quantities. Several of these algebraic expressions in terms of base units can be replaced by special names and symbols which can themselves be used to form other derived units (see II.2, page 6).

Although it might be thought that SI units can only be base units or derived units, the 11th CGPM (1960) admitted a third class of SI units, called supplementary units, for which it declined to state whether they were base units or derived units (see II.3, page 11).

The SI units of these three classes form a coherent set in the sense normally attributed to the expression "coherent system of units".

The decimal multiples and submultiples of SI units formed by means of SI prefixes must be given their full name *multiples and submultiples of SI units* when it is desired to make a distinction between them and the coherent set of SI units."

It would not be quite right to let the matter end so abruptly. In the first place it leaves an impression of unnecessary arbitrariness, if not capriciousness, that is quite unjustified. In the second place it is not much help to people who will not be content intellectually to accept such an explanation. As a result of natural curiousity, many people will wish to make a connection between Base Units and basic physics, and some differences of opinion and misunderstandings will surely arise. In many cases such misunderstandings will be a natural part of thinking and learning processes. For those who find themselves in this position, the following remarks may be helpful.

The origin of a major part of the confusion probably springs from the association of the Base Units with the role played by mass, length, and time in the field of classical mechanics. In mechanics we find that if we define units for each of these three quantities, we have the ability to define a scale of measurement for all other mechanical quantities. The further invention of the method of dimensional analysis to check the correctness of the balance of the two sides of an equation, and adoption of this method for expressing the SI Derived Units in terms of the SI Base Units, tends to fix more deeply the notion of fundamentality to these units. This fixation leads, more usually than not, to conceptual difficulties when we have to deal with more recent physical ideas embodied in relativity theory and quantum theory, particularly when we are asked to accept the use of natural units, i.e., $c=1$, $\hbar=1$.

The probable origin of most of our confusion is that for the most part we are dealing with conventions of how we wish to measure (i.e., express an observed quantity in numbers), and to a lesser extent with how to express the Laws of Physics by means of mathematical equations. Let us mention first a philosophical point: in physics we make the fundamental assumption that the Universe operates in such a fashion that what we observe can be reduced to a series of mathematical equations connecting certain important quantities that we perceive to be measurable. By means of a series of measurements we are able to check the validity of our equations and so develop an intricate conceptual structure that is internally self-consistent and which we believe to be a valid representation of nature. Our great confidence in the validity of this view of nature is based upon a long and systematic application of the method of controlled experiment, which has reached at the present day an exceedingly high level of sophistication. The method of controlled experiment is nowadays entirely dependent upon our ability to devise and execute precise measurements. In defining our system of measurement we draw upon the mathematically expressed laws of physics, and build up a physical measurement system in a logical and systematic fashion.

**The metre is defined as 1 650 763.73 wavelengths in vacuum of the orange-red line of the spectrum of krypton-86.**

Consider a few of the better known equations in classical physics:

Newton's Second Law of Motion, where $m_i$ is called the inertial mass, $F_i \propto m_i a$ Newton's Law of Gravitation, where $m_g$ is called the gravitational mass, $F_g \propto m_g m^1_g/r^2$ and where we find experimentally $m_i \propto m_g$.

[2] The 13th CGPM (1967) considered the introduction of the mole into the International System and instructed the CIPM to prepare a draft accordingly. In 1969 the CIPM approved a draft resolution for submission to the 14th CGPM (1971) to the effect that the mole should be declared a base unit (See II.1.1g, page 5).

[3] Translators' note. The spellings "metre" and "kilogram" are used in this USA/UK translation in the hope of securing worldwide uniformity in the English spelling of the names of the units of the International System.

The first thing we wish to point out is that it is really a matter of taste whether, for example, we look upon Newton's Second Law as a postulate, fundamental law of physics or definition of the quantities force and inertial mass. The second thing to note is that we have written the above equation with a symbol of proportionality rather than of equality without in any way whatsoever lessening the physical meaning implied by the equations. As a practical matter, however, as soon as we wish to check experimentally the validity of the equations or to use them, it becomes necessary to express concepts such as length, time, velocity, mass, momentum, force, electric charge and so on in numbers. In order to express these concepts in number we must have a scale, a unit measure, or a standard value. If we had found that for all of these concepts nature had provided us with a natural intuitive way of relating to them and provided us with a natural unit by which to measure them, (i.e. there was a unique value the magnitude of which we could easily comprehend, accurately determine and readily use, as we shall claim later is the case with angle) then we should have no trouble with scales—there would be a natural scale for all quantities and unambiguous constants of proportionality could be determined for each physical equation, such as the ones given above. In this hypothetical case the question of basic units and derived units would simply not arise.

In the way physics has developed there have appeared few natural units* and historically one has had to define arbitrary scales for the measurement of quantities. The practice has been to define as few such arbitrary scales as possible, to give preference to attributes such as accuracy and reproducibility in place and time, and then to use equations such as the ones given above to define the scales of other quantities by choosing the constants of proportionality in the physical equations that connect them to be as simple as possible—unity in many cases. By this general procedure our units of measure are made coherent with the Laws of Physics.

**The second is defined as the duration of 9 192 631 770 cycles of the radiation associated with a specified transition of the cesium atom.**

Thus in the SI we define the scales of mass, length and time arbitrarily and use Newton's Second Law to define force by setting the constant of proportionality in the equation equal to unity. Then we wish to have only one scale of mass so we set the scales of inertial and gravitational mass equal (experiment must first show that the ratio of gravitational to inertial mass is the same for all substances, which the Eötvos experiment has done to a high degree of accuracy). This fixes the scales of all quantities in the Law of Gravitation and hence makes the constant of proportionality, $G$, a quantity that must then be determined by experiment. It is generally agreed that experiments show $G$ to have the value $6.6732 \pm 0.0031 \times 10^{-11}$ when force is expressed in newtons, mass in kilograms and distance in metres. It is also said that $G$ has dimension of $(\text{mass})^{-1}\ (\text{length})^{3}\ (\text{time})^{-2}$. We see that no intrinsic importance must be attached to this latter fact, only the very practical importance that when we determine the constant in an equation in physics, or when we express the result of an observation in numbers, we must—as we are taught early—identify the system of units we are using.

The central characteristic of the SI units is that the system follows the pattern outlined above. The system is built up by starting with the experimental definition of a few Base Units, and then by systematically defining other units in terms of the Base Units by using certain equations of physics. The use that is made of these equations is that the constants of proportionality relating the two sides are fixed by definition, often by setting them equal to unity and calling them "dimensionless". The reasons for choosing which units we select for Base Units are really the very practical ones of accuracy, reproducibility, directness and convenience. *If it were to be recommended at some time in the future that we should restructure our measurement system, the touchstone we should adopt for considering modifying the system is one of practical utility.*

Having said this much, however, we recognize that many people will not find this explanation entirely satisfying. It is inevitable to ask questions such as, why are three Base Units needed to set up a coherent system of measurement for mechanical quantities? Is it more fundamental to use Lorentz invariant quantities such as the rest mass of a fundamental particle, Planck's constant and the speed of light for Base Units than the kilogram, second and metre? Is there anything less "basic" about the unit of angle than the unit of length? Do electrical units have to be defined by relating them to mechanical units? Is it sensible in high energy physics to ask what are the dimensions of isotopic spin, strangeness, baryon number, etc. when these quantities do not appear in classical physics? Does the inclusion of the mole, the kelvin, and the candela as Base Units imply some equal attribute of fundamentality (if this statement has any meaning) to these units as compared to the metre, the kilogram, the second, and the ampere?

We feel that questions such as these reflect a natural intellectual curiosity about the nature of units and measurement. We believe that such curiosity should be welcomed, but for its own sake rather than because it necessarily

*We leave aside here the early history of time scales, and simply note that the period of rotation of the earth about its own axis, the period of rotation of the earth around the sun, and the period of rotation of the moon around the earth, presented three natural but inconsistent time scales that our ancestors had a lot of trouble understanding and reconciling.

helps us set up a better metrological system. Recognizing this point of view we shall attempt to give some discussion on the above points.

In setting up a system of units for measuring purely mechanical quantities it is certainly an empirical fact that we need to define three units by giving methods of realizing the units without reference to any other unit. There is no intrinsic reason why one has to choose mass, length and time rather than $m_0$, $c$, and $\hbar$, or some other set. While there would be aesthetic satisfaction for choosing Lorentz invariant quantities, and perhaps also the practical advantage of greater constancy in place and time, the system would founder or flourish on our ability to realize the units in practice with an accuracy greater than that we achieve with the present Base Units.

As far as using a smaller number of Base Units, it has not been found possible to set up a complete system of measurement with less than three units defined independently. It must be regarded at present simply as an empirical fact that we have been able to discover no deeper laws of nature that would allow this, for example by discovering an algebraic combination of $m_0$, $c$, and h that equals some constant number.

**The standard for the unit of mass, the kilogram, is a cylinder of platinum-iridium alloy kept by the International Bureau of Weights and Measures at Paris. This is the only base unit still defined by an artifact.**

The unit of length measures a translation in space, and the unit of angle measures a rotation, both of which are geometrical operations. We make the *physical* assumption (well-founded on experience) that space is isotropic. This leads directly to the conclusion that we can use one standard of length rather than three, one each for north, east, and, say, up. It also leads to the conclusion that we are justified in dividing one complete rotation into a given number of equal parts. There is an interesting difference here, however, that we have a "natural unit" of angle, *viz* one complete rotation, so that the realization of the unit of angle is a purely geometrical operation and does not draw upon physics except through the isotropy assumption. This is not the case with length (assuming space is Euclidian, which it is, except perhaps when we are dealing with the great distances and large masses that appear in astronomy). In comparing length with angle, we might wish to compare the corresponding invariance theorems. If the Hamiltonian for a system is invariant under translation, in a given direction, then the linear momentum of the system in that direction is conserved. Similarly if the Hamiltonian is invariant under rotations about a given axis, then the angular momentum is conserved about that axis. The question whether length is more fundamental than angle is then transformed into asking whether linear momentum is any more fundamental than angular momentum. It is not clear how this question should be interpreted, as long as experiment indicates that both remain conserved quantities.

In the cgs system, units with which to measure electromagnetic quantities are introduced by means of Coulomb's Law:

$$F_e \propto ee'/r^2.$$

The proportionality is transformed into an equality by setting the constant of proportionality equal to unity and the size of the unit of electric charge in esu is thereby defined. It is said to have dimension $(\text{mass})^{1/2}$ $(\text{length})^{3/2}$ $(\text{time})^{-1}$, but this notion is confusing since the whole concept of electric charge introduces an entirely new quantity from the mechanical quantities. In the MKSA system, also taken over into the SI, the unit defined is that of current, the ampere, by means of the law connecting magnetic forces between currents. In this case, however, the constant of proportionality is set equal to $4\pi \times 10^{-7}$, is called the magnetic constant, and is said to have dimension (metre) (kilogram) $(\text{second})^{-2}$ $(\text{ampere})^{-2}$. Since a system of electric currents can be generated from a system of electric charges by means of a simple transformation to a moving coordinate system, the two methods of defining electrical units could be made exactly equivalent.

An alternative way to proceed is to take advantage of the fact that electric charge is quantized and that the charge on all fundamental particles

**The thermodynamic or Kelvin scale of temperature used in SI has its origin or zero point at absolute zero and has a fixed point at the triple point of water defined as 273.16 kelvins.**

is found to have a low integral value, usually 0, $\pm 1$. The charge on a particle, is moreover, a Lorentz invariant quantity so that it has the advantage of a "natural" definition of a unit. The result of this procedure is to use natural quantum numbers as our scales, a great convenience that is frequently adopted in high energy physics. We then see the appearance of scales for quantities such as energy that are given in units of the charged pion rest mass, and so on. These scales are a great convenience in places where they are used, but this is certainly not the case in classical electromagnetism and particularly not in electrical engineering. In these latter cases it is desirable to have both mechanical and electrical forces and energies (which, as we know, are always equivalent) expressed in the same units, and this is precisely what is done in setting up the SI units.

In the physics of elementary particles it has been found necessary to postulate the existence of quantities such as isotopic spin, strangeness, baryon number and so on. These quantities are exchanged in discrete amounts in high energy interactions

between particles and are "measured" by means of quantum numbers in the same ways electric charge is "measured." All measurements on elementary particles ultimately are classical in nature (droplets in a cloud chamber or bubbles or sparks in their respective chambers). These are possible because of the long range electromagnetic forces which ionize the media charged particles traverse. Perhaps for this reason, no new base units are required for the short range strong and weak forces responsible for the interactions between elementary particles. The only long range forces we know of are the electromagnetic and gravitational interactions.

The mole, the kelvin, and the candela are given specific operational definitions and are included as base units. The mole defines what is called the "quantity of substance". Alternatively one might say that it gives an operational definition to Avagadro's number as the number of atoms of $C^{12}$ in 12 grams of $C^{12}$. This experimental algorithm is made necessary mainly because of our inability to count one by one very large numbers of particles with the precision with which we can compare large numbers by other means, for example by chemical means.

**The ampere is defined as the magnitude of the current that, when flowing through each of two long parallel wires separated by one metre in free space, results in a force between the two wires (due to their magnetic fields) of 2 x $10^{-7}$ newton for each metre of length.**

In order to understand the exchange of energy (heat flow) and dynamical properties of systems containing very large numbers of particles, the intellectual structures of thermodynamics and statistical mechanics have been developed. In particular, for the description of thermal phenomena two new concepts of great fundamental importance were introduced, the "degree of heat", or temperature, $T$, and the entropy, S. Underlying these notions is the fundamental property of the number of state of a system and the degree of accessibility of these states with the energy possessed by the system. These quantities are related to the quantity of heat, Q, through the relation:

$$dQ \propto T ds.$$

Temperature is an observable of great metrological importance since it appears explicitly in most predictions of thermodynamic theory, and is a quantity which is comparatively easy to compare experimentally for different systems. Now if there were some advantage from a symbolistic point of view, it would be possible to avoid the introduction of another base unit, and perhaps define $T$ as a pure number or as an energy. Neither of these alternatives seems desirable, however, since neither temperature nor entropy can be regarded at all as the same physical quantity as energy, and on that account it would prove to be impossible in practice to measure either of them uniquely in terms of an energy scale. Accordingly an absolute scale of temperature is defined with a Base Unit we call the kelvin. The proportionality sign in the above equation is replaced by an equality and entropy is then measured in the unit "joule per kelvin".

At first sight it might appear that the candela may be an intruder into the group of Base Units in that it represents a psychophysical unit. It comes close to this but it is not quite so, and consequently cannot be excluded simply on that account. The candela measures luminous intensity, and indeed "luminous" does refer to that part of the electromagnetic spectrum to which the eye is responsive. However, luminous intensity was deliberately defined to avoid human variance. It was defined by a combination of physics and mathematics. It is a combination of a physical quantity, the spectral intensity distribution, and a mathematical curve called the Photopic Luminous Efficiency Curve (CIPM, 1933). The physical quantity is a distribution of energy flux over wavelength, and this is weighted according to the mathematical curve and integrated over wavelength. The Photopic Luminous Efficiency Curve is selected to represent some average response curve for the human eye, but it is in fact a mathematical curve and has been chosen to allow a separation of physical and psychophysical experimentation and a separation of variables into the respective fields. A single unit that can express luminous intensity is still most useful particularly in illumination engineering, and it could be argued that it should be retained on that account.

**The candela is defined as the luminous intensity of 1/600 000 of a square metre of a radiating cavity at the temperature of freezing platinum (2042 K).**

There is an aesthetic objection on the part of many people to doing this, however, partly because of the very restricted application of the unit and partly because it cannot be regarded as anything remotely resembling a cornerstone of a physical measurement system. The unit cannot be used in spectrophotometry, in radiometry, in measuring high energy x-ray and $\gamma$-ray flux, and not too well in psychophysics, where, in the perception of brightness, a theory that the receptor acts as a spectral filter the output of which is integrated over wavelength by another mechanism higher up in the nervous system is surely not the best. So one day the candela may have to go as a Base Unit, although continuing to be used as an important unit in illumination engineering.

# FIRST METRIC STUDY REPORT
# FEATURES INTERNATIONAL STANDARDS

## Lack of U.S. Participation Cited

SECRETARY OF COMMERCE MAURICE H. STANS has announced his transmittal to the Congress of the first interim report[1] from the U.S. Metric Study. The Secretary concurred in its "substantial concern about the need to strengthen the effectiveness of the United States in international standard negotiations."

"The matters discussed in this report are of the greatest importance to our international trading ability," Mr. Stans said. "Our reaction to it will determine our position in the world market for many years. We have too long pursued an unofficial policy of indifference to international standardization. It is time either to alter this stance, or, if we are to maintain it, to do so by choice rather than inadvertence."

The report is part of a 3-year study conducted by the Bureau to determine the impact on this country of increasing worldwide and domestic use of the metric system. In the course of the Study it became clear that the problem of international standardization was becoming an increasingly important concern throughout the world and merited immediate attention. A special task force was therefore assembled within the Study Group to explore the area in detail and prepare this first interim report.

The report acknowledges the excellent internal network of engineering standards in the United States, which would be sufficient were we a nation apart. It emphasizes however that when we trade, or hope to trade, in world markets, international standards assume prime importance.

Recommendations by the two worldwide leaders in international standardization—the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO)—the report points out, reflect the engineering practices of the nations that participate in drafting them. As a consequence, a nation which does not participate at the drafting stage may later find its standards and practices different, and suffer a consequent disadvantage in international trade. If the United States is to have its practices reflected in international recommendations, it must participate more actively on the drafting committees of these organizations.

The report also discusses the importance of negotiations with other countries in the engineering standards area. International standards provide a means for fostering or hindering trade; in the latter case, as a nontariff trade barrier. Product certification, coupled with international standards development, may be used to open or shut markets.

An example of this market control is the Tripartite Agreement, an agreement among the United Kingdom, France, and West Germany that bases standards for electronic components on IEC recommendations and sets up a scheme for quality assurance and product certification. The rules of the Tripartite Agreement require each nation to have an authorized institution for the certification procedures. Moreover the institution must speak for its own government, and be acceptable to other nations. The central benefit of membership in this scheme is that full faith and credit is given by member countries to the certification of any member. On the other hand, products of non-member countries are placed at competitive disadvantage because they must be tested and certified before entry into the market is permitted.

This certification scheme leaves the United States with two choices if it wishes to continue exporting subject products to certification countries:

1. To enter into and fulfill the requirements of the certification agreement (which at present it is not undertaking to accomplish), or

2. To make products clearly superior to the certification standards (as judged by the customers and the acceptance officials) and to insure that the export products do, in fact, meet the superior standards.

After an extensive analysis of the results of its investigation, the Task Force has included in its report the following conclusions and recommendations:

### CONCLUSIONS

*Conclusion 1:* The international standards issue lends some support to a metric conversion in the United States, but other important issues must also be considered and weighed before an overall judgment can be made.

*Conclusion 2:* The Metric Study cannot and should not be expected to provide answers for the nonmetric issues raised by the events and trends described in this report.

*Conclusion 3:* If the U.S. wishes

to see the maximum amount of its engineering practices and standards included in the coming international standards, it must, without delay, take steps for adequate and effective participation in international standards negotiations.

Two points about this third conclusion require emphasis:

a. The question of the extent to which participation in international standardization is in the best interest of the United States must be decided on the basis of considerations that are beyond the scope of the U.S. Metric Study.
b. This decision need not (and should not) await the outcome of the Metric Study.

*Conclusion 4:* If the United States increases and makes more effective its participation in international standards-making activities, then the degree of incompatibility between U.S. domestic standards and international recommendations would be reduced, and a U.S. metrication program would be facilitiated, should we take this course.

*Conclusion 5:* Relatively modest changes in the import-export pattern of measurement sensitive goods can have a serious impact on the U.S. balance of payments. Hence, the relation between standards, standards utilization and trade should be the subject of careful study to develop the policy basis for U.S. participation in international standards development and utilization.

*Conclusion 6:* SI usage in international standards as a language does not of itself pose any serious complications to the U.S.

*Conclusion 7:* Product certification emerges as a primary consideration in the utilization of standards.

*Conclusion 8:* Some product certification scheme for exports will probably be required to maintain a competitive position if European plans are successful. It can be either a plan compatible with those now developing in Europe or a distinctively U.S. approach, conceived to provide adequate assurance that U.S. export products meet a set of explicitly stated standards.

*Conclusion 9:* If the U.S. elects to certify products in terms of IEC–ISO standards, it must recognize that the critical decade of standards development is here and take the necessary steps for participation.

## RECOMMENDATIONS

*Recommendation 1:* The Department of Commerce should take appropriate steps to determine whether the economc impact of agreements such as the Tripartite Agreement can be expected to affect the U.S. balance of payments significantly or otherwise work against the best interests of the United States.

*Recommendation 2:* The Department of Commerce should devise, in concert with other interested Federal agencies and responsible standardizing institutions, a firm U.S. policy about participation in international standards activities, including what role the Government should play and provisions for furthering the public interest as well as the competitive position of U.S. industry in world trade.

*Recommendation 3:* If such a policy dictates increased participation, appropriate steps should be taken to see that such participation is sufficient to meet the rapidly increasing international standardization activities that have been predicted for this decade.

*Recommendation 4:* The Department of Commerce should, in concert with other interested Federal agencies, initiate action to determine whether or not the United States should participate in international product certification agreements. If adherence to such agreements is deemed desirable, an appropriate mechanism for certification within the U.S. should be developed. If adherence is not believed warranted, the U.S. should ensure that an appropriate alternative strategy is devised and followed.

*Recommendation 5:* Finally, the actions indicated above should be taken without awaiting the outcome of the U.S. Metric Study, but drawing upon it for relevant information.

## BACKGROUND

The U.S. Metric Study (Public Law 90–472), authorized by Congress in 1968, required the Secretary of Commerce to conduct a 3-year program of investigation, research, and survey to determine the impact on this country of increasing worldwide and domestic use of the metric system. Responsibility for the study was delegated by the Secretary to the National Bureau of Standards, where the study is being conducted under the direction of Daniel V. DeSimone.

Varied approaches are being used in making the study. The Metric Study Group has identified 455 classes of manufacturing as "measurement-standards sensitive." Examination of trade statistics shows that these 455 classes accounted for $11 billion of exports and $4 billion of imports in 1969. Thus, in terms of exports and imports that are measurement-standards sensitive, there was a favorable balance of $7 billion for the U.S. in 1969. There is clearly much at stake in the export and import of these kinds of products, although the extent to which the measurement-standards factor affects the trade balance is unknown.

A series of national conferences,[2] involving representatives of such groups as labor, consumers, manufacturers, education, and others, has been held to provide a forum for interested groups. Extensive surveys have been made of both manufacturing and non-manufacturing industry, the results of which are now being analyzed.

The report of the Secretary of Commerce to the Congress will be made in August 1971 and will be made available to the public shortly thereafter.

[1] U.S. Metric Study Report, International Standards, Nat. Bur. Stand. (U.S.), Spec. Publ. 345–1, 157 pages (Dec. 1970), $1.25. Order from Superintendent of Documents, U.S. Govt. Printing Office, by SD Catalog No. C13.10:345–1.
[2] Metric study enters data gathering phase, NBS Tech. News Bull. 54, 212 (June 1970).

# REVISED LIST OF PHYSICAL CONSTANTS

THE BUREAU has published a new interim set of values for the physical constants as a part of the ninth printing of its well known Handbook of Mathematical Functions.[1] The new values are based on the most recent comprehensive evaluation of the constants by Taylor, Parker, and Langenberg,[2] who carried out a least squares adjustment of the earlier data combined with a large body of new measurement results reported by physicists since 1963 when Cohen and DuMond completed the last major readjustment.[3] Many of the new measurements were obtained with considerably improved techniques; particularly noteworthy was the successful application of the a-c Josephson effect to the determination of the ratio of the electronic charge to Planck's constant.[4]

A list of some of the more widely used constants, based on the values obtained by Taylor, Parker, and Langenberg (TPL), is shown in Table 1. This shorter table will also be used in a revised edition of the NBS wallet-card list of General Physical Constants.[5] The Defined Values and Conversion Factors, shown here as Table 2, will also appear on the card,

**THE MODERNIZED METRIC SYSTEM**

**The International System of Units (SI), established in 1960 by the General Conference of Weights and Measures under the Treaty of the Meter, is based on: the metre (m) for length, defined as 1 650 763.73 wavelengths in vacuum corresponding to the transition $2p_{10}$–$5d_5$ of krypton 86; the kilogram (kg) for mass, defined as the mass of the prototype kilogram at Sevres, France; the second (s) for time, defined as the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of cesium 133; the kelvin (K) for temperature, defined as 1/273.16 of the thermodynamic temperature of the triple point of water; the ampere (A) for electric current, defined as the current that, if flowing in two infinitely long parallel wires in vacuum separated by one metre, would produce between the wires a force of $2 \times 10^{-7}$ newton per metre of length; and the candela (cd) for luminous intensity, defined as the luminous intensity of 1/600 000 square metre of a blackbody at the temperature of freezing platinum.**

*Table 1. General Physical Constants*

| CONSTANT | SYMBOL | VALUE | UNCERTAINTY* | UNITS: SYSTEME INTERNAT. (SI) | | UNITS: CENTIMETER-GRAM-SECOND (CGS) | |
|---|---|---|---|---|---|---|---|
| Speed of light in vacuum | $c$ | 2.997 925 0 | ±10 | $\times 10^{8}$ | m/s | $\times 10^{10}$ | cm/s |
| Elementary charge | $e$ | 1.602 191 7 | 70 | $10^{-19}$ | C | $10^{-20}$ | $cm^{1/2}g^{1/2}$† |
| | | 4.803 250 | 21 | ........ | ........ | $10^{-10}$ | $cm^{3/2}g^{1/2}s^{-1}$‡ |
| Avogadro constant | $N_A$ | 6.022 169 | 40** | $10^{23}$ | $mol^{-1}$ | $10^{23}$ | $mol^{-1}$ |
| Atomic mass unit | u | 1.660 531 | 11** | $10^{-27}$ | kg | $10^{-24}$ | g |
| Electron rest mass | $m_e$ | 9.109 558 | 54 | $10^{-31}$ | kg | $10^{-28}$ | g |
| Proton rest mass | $m_p$ | 1.672 614 | 11** | $10^{-27}$ | kg | $10^{-24}$ | g |
| Faraday constant | $F$ | 9.648 670 | 54** | $10^{4}$ | C/mol | $10^{3}$ | $cm^{1/2}g^{1/2}mol^{-1}$† |
| Planck constant | $h$ | 6.626 196 | 50 | $10^{-34}$ | J·s | $10^{-27}$ | erg·s |
| Fine structure constant | $\alpha$ | 7.297 351 | 11 | $10^{-3}$ | ........ | $10^{-3}$ | ........ |
| Charge to mass ratio for electron | $e/m_e$ | 1.758 802 8 | 54 | $10^{11}$ | C/kg | $10^{7}$ | $cm^{1/2}/g^{1/2}$† |
| | | 5.272 759 | 16 | ........ | ........ | $10^{17}$ | $cm^{3/2}g^{-1/2}s^{-1}$‡ |
| Rydberg constant | $R_\infty$ | 1.097 373 12 | 11 | $10^{7}$ | $m^{-1}$ | $10^{5}$ | $cm^{-1}$ |
| Gyromagnetic ratio of proton | $\gamma_p$ | 2.675 196 5 | 82 | $10^{8}$ | $rad \cdot s^{-1}T^{-1}$ | $10^{4}$ | $rad \cdot s^{-1}G^{-1}$† |
| (uncorrected for diamag., $H_2O$) | $\gamma'_p$ | 2.675 127 0 | 82 | $10^{8}$ | $rad \cdot s^{-1}T^{-1}$ | $10^{4}$ | $rad \cdot s^{-1}G^{-1}$† |
| Bohr magneton | $\mu_B$ | 9.274 096 | 65 | $10^{-24}$ | J/T | $10^{-21}$ | erg/G† |
| Gas constant | $R$ | 8.314 34 | 35 | $10^{0}$ | $J \cdot K^{-1}mol^{-1}$ | $10^{7}$ | $erg \cdot K^{-1}mol^{-1}$ |
| Boltzmann constant | $k$ | 1.380 622 | 59 | $10^{-23}$ | J/K | $10^{-16}$ | erg/K |
| First radiation constant ($8\pi hc$) | $c_1$ | 4.992 579 | 38 | $10^{-24}$ | J·m | $10^{-15}$ | erg·cm |
| Second radiation constant | $c_2$ | 1.438 833 | 61 | $10^{-2}$ | m·K | $10^{0}$ | cm·K |
| Stefan-Boltzmann constant | $\sigma$ | 5.669 61 | 96 | $10^{-8}$ | $W \cdot m^{-2}K^{-4}$ | $10^{-5}$ | $erg \cdot cm^{-2}s^{-1}K^{-4}$ |
| Gravitational constant | G | 6.673 2 | 31 | $10^{-11}$ | $N \cdot m^2/kg^2$ | $10^{-8}$ | $dyn \cdot cm^2/g^2$ |

*Based on 1 std. dev.; applies to last digits in preceding column. †Electromag. system. ‡Electrostatic system.
**These values may be in conflict with data available since the Taylor, Parker, Langenberg review. Pending a complete new readjustment of the constants, it would be prudent to multiply the above uncertainties by 3.

*Table 2. Defined Values and Conversion Factors*

| | |
|---|---|
| Atomic mass unit (u) | 1/12 the mass of an atom of the $^{12}C$ nuclide |
| Standard acceleration of free fall | 9.806 65 m/s², 980.665 cm/s² |
| Standard atmosphere | 101 325 N/m², 1 013 250 dyn/cm² |
| Thermochemical calorie | 4.184 J, 4.184 × 10⁷ ergs |
| Int. Steam Table calorie | 4.1868 J, 4.1868 × 10⁷ ergs |
| Liter | 0.001 cubic metre |
| Mole (mol) | amount of substance comprising as many elementary units as there are atoms in 0.012 kg of $^{12}C$ |
| Inch | 0.0254 m, 2.54 cm |
| Pound, avdp. | 0.453 592 37 kg, 453.592 37 g |

as well as definitions of the base units of the modernized metric system, i.e. the International System of Units (SI).[6]

Activity in the measurement of physical constants continues at so high a rate that another readjustment has been initiated by the Task Group on Fundamental Constants of the Committee on Data for Science and Technology, International Council of Scientific Unions. This, however, may take a year or two. Meanwhile, it is generally agreed that the TPL values not only best represent the information available through mid-1969, but that the results of the next readjustment will be much closer to the TPL values than to the 1963 Cohen and DuMond values.

[1] Chapter 2, NBS Applied Mathematics Series 55, Handbook of Mathematical Functions, Ninth Printing, Feb. 1971. Price $9.00; for sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[2] Taylor, B. N., Parker, W. H., and Langenberg, D. N., Rev. Mod. Phys. **41**, 375 (1969). Also available in book form: "The Fundamental Constants and Quantum Electrodynamics" by same authors, Academic Press, New York 1969.

[3] NBS Tech. News Bull. **47**, 175 (Oct. 1963).

[4] "The Fundamental Physical Constants" by B. N. Taylor, D. N. Langenberg, and W. H. Parker, Scientific American, 62–73 (Oct. 1970).

[5] **General Physical Constants,** NBS Special Publication 344 (supersedes NBS Misc. Publ. 253), plastic card 2⅝ by 3¾ inches. Price 10 cents each, $6.25 per 100; for sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; order as C13.10:344.

[6] For the full official description of the system, see "The International System of Units (SI)", NBS Special Publication 330, Jan. 1971. Price 50 cents. Order from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 as C13.10:330.

## LITHIUM VAPOR *Continued*

through a port tangential to the accelerator's doughnut. The radiation is then passed through and partially absorbed by lithium vapor in a specially designed heat pipe oven. The electronic excitation states are analyzed from line spectra obtained from a grazing-incidence spectrograph and from intensity scans derived from a scanning monochromator.

The development of the heat-pipe oven enabled the investigators to produce a chemically pure vapor of lithium. The oven, a 35-centimeter long stainless steel pipe, is encased within an evacuated quartz tube and is mounted in a section of the synchrotron's light pipe. Aluminum windows, 1000 Å thick, seal the oven at both ends. The lithium vapor is maintained in the central 25 centimeters of the pipe under a slight argon pressure (133 to 1333 N/m²) at both ends to keep the vapor from clouding or corroding the windows. An rf coil wrapped around the center of the tube (over a length of about 15 centimeters) heats the vapor. The internal wall of the pipe contains a stainless steel mesh which acts as a wick for condensing the vapor and transporting the liquid lithium from the cooler regions of the vapor section back to the center for reheating. The hot zone of the pipe is at a practically uniform temperature at about 725°C with variations of only 1°C.

## RESULTS

This work represents the first optical measurements of the autoionizing states of lithium. Theoretically these states or "continuum resonances" are due to the excitation of a K-shell electron or to the simultaneous excitation of a K-shell electron and the valence electron. The lowest lying optically allowed transition is the excitation of an autoionization state $1s(2s2p\ ^3P)\ ^2P$ and lies at 210.5Å. The next spectral peaks correspond to the states $1s(2s2p\ ^1P)\ ^2P$ (205.3Å), $(1s2s\ ^3S)3p\ ^2P$ (198.6Å), $(1s2s\ ^3S)4p\ ^2P$ (195.7Å), and $(1s2s\ ^3S)5p\ ^2P$ (194.5Å), respectively. The positions of these resonances were predicted to within 0.7 Å by a multiconfiguration calculation performed by Dr. Weiss.

A multiconfiguration calculation is intractible in the vicinity of or above the series limit $1s2s\ ^3S$ (192.5 Å) and another technique was applied by Cooper, et al[4] to calculate the resonance positions in the region between the $1s2s\ 2^3S$ and $1s2p\ ^1P$ limits. This technique employs the close-coupling approximation to calculate the positions of resonances above the $1s2s\ ^3S$ limit. These calculations provided the interpretation of the spectrum above the $1s2s\ ^3S$ limit and also the completion of the assignment of the levels lying below the $1s2s\ ^3S$ limit.

The data obtained thus far are of a preliminary nature, and much work remains to give a more complete account of the lithium structure. Future plans include: the extension of the observations to below the present aluminum cutoff $L_{2,3}$ at 170Å by using windows of carbon or beryllium; the search for weaker resonances by using high-lithium pressures and longer furnaces; and the refinement of the close-coupling calculations to give a more detailed explanation of the spectrum above the $2^3S$ limit.

[1] For further details, see Ederer, D. L., Lucatorto, T., and Madden, R. P., Autoionization spectra of lithium, Phys. Rev. Letters **25**, No. 22, 1537–1540 (Nov. 1970).

[2] Heat-pipe oven generates homogeneous metal vapors, Nat. Bur. Stand. (U.S.), Tech. News Bull. **53**, No. 8, 172–173 (Aug. 1969).

[3] NBS installs synchrotron at Gaithersburg laboratories, Nat. Bur. Stand. (U.S.), Tech. News Bull. **53**, No. 1, 4–5 (Jan. 1969).

[4] Cooper, J. W., Conneely, M. J., Smith, Kenneth, and Ormonde, Stephan, Resonant structure of lithium between the $2^3S$ and $2^1P$ thresholds, Phys. Rev. Letters **25**, No. 22, 1540–1543 (Nov. 1970).

# AN ACCURATE
# MERCURY MANOMETER
# FOR THE NBS GAS THERMOMETER

A Mercury Manometer of Exceptional Accuracy has been developed as a result of an effort to increase the accuracy of gas thermometry. The manometer[1] is the result of refinements over the years by L. A. Guildner, H. F. Stimson, R. E. Edsinger, and R. L. Anderson of the Heat Division. The manometer has an accuracy within two parts per million from $1\times10^4$ to $1.3\times10^5$ pascals or $N/m^2$ (76 to 1000 torr). It was designed for, and has been primarily used with, the NBS Gas Thermometer, thought to be the most accurate thermometer of its type in the world. The gas thermometer is being used to measure temperatures directly on the Kelvin Thermodynamic Temperature Scale along with the corresponding values of temperature on the International Practical Temperature Scale of 1968 between 0 and 1064 °C.

Manometers are devices for measuring differences of pressure. For such determinations one can utilize the height of a column of liquid, a weight applied to a confined piston, tensions from deflection of diaphragms or springs, etc. If the measurements are of the pressure in excess of a vacuum, the device is an absolute manometer, and if the absolute manometer is measuring atmospheric pressure, it is a barometer. Determinations of pressure differences by liquid column manometers can have high accuracy because the measured quantities can be determined with high accuracy and are simply related to the definition of pressure, i.e. Force/Area$=\rho gh$, where $\rho$ is the density of the liquid, g is the acceleration due to gravity, and h is the differential height of the liquid columns. Efforts to improve the accuracy of liquid manometers must necessarily deal with improvements in the determinations of $\rho$ and h.

The manometers of highest relative accuracy are mercury manometers. This is true because the properties of mercury, in combination, make it the most nearly ideal manometric liquid available. Mercury can be made very pure by relatively simple techniques and it does not absorb gases significantly. Thus, very exact determinations of the density of mercury are reliable and applicable in a straightforward way to all mercury manometers. Mercury also is suitable for manometry because its vapor pressure is low and reproducible. The high density of mercury allows pressures up to one or two atmospheres to be measured with a column of reasonable height. This height can be accurately determined when the crowns of the menisci are located by optical means, but the most exact method of locating the crowns makes use of capacitance. If the mercury is used as an electrode of a three-terminal capacitor, as in the NBS manometer, the average separation between the mercury surface and a guarded capacitance plate will be reproduced within 1 or 2 nm for the same capacitance.

In this fourth model * three fundamental concepts have been retained. First, each menicus is large enough in diameter for the effect of capillary depression and any possible change of the shape of the crown to be always negligible. Second, the position of each crown is established by the electrical capacitance between it and a precisely located capacitance plate. Finally, the vertical height of the mercury column supported by gas pressure in the lower cells is measured by gage blocks.

While previous models were elaborate versions of metal U-tubes, the present NBS mercury manometer is more nearly a metal W-tube, with the three menisci contained in "cells" at the upper ends of the tubes. The manometer has a long mercury column in the center, connected at the top to an "upper cell." The long column is an articulated arm and is connected through a pair of short columns on either side to two "lower cells." The three cells are supported on pedestals that have their upper surfaces in a single horizontal plane and which in turn are supported in line by a rigid stable base. This arrange-

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Correction: A minor error appeared in the article on SI policy appearing in the Jan. 1971 Technical News Bulletin. On page 21, in item 8 at the end of the article the last entry on line 5 should be "J·not "J/.

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*The present manometer has evolved from the original concepts for an accurate instrument initiated by C. S. Cragoe and T. B. Godfrey and improved by C. H. Meyers and R. D. Thompson. It was brought into operating status by H. F. Stimson in the second model and further improved by him in the third model.



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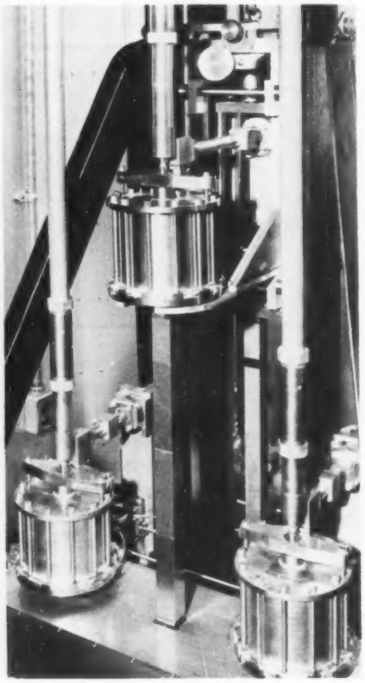


*The main components of the exceptionally accurate mercury manometer developed at NBS are illustrated in this photograph. The center cell rests on gage blocks whose height equals the height of a mercury column necessary to balance the desired pressure.*

ment permits the capacitances with the mercury surfaces in the two lower cells to compensate for small changes in level of the base.

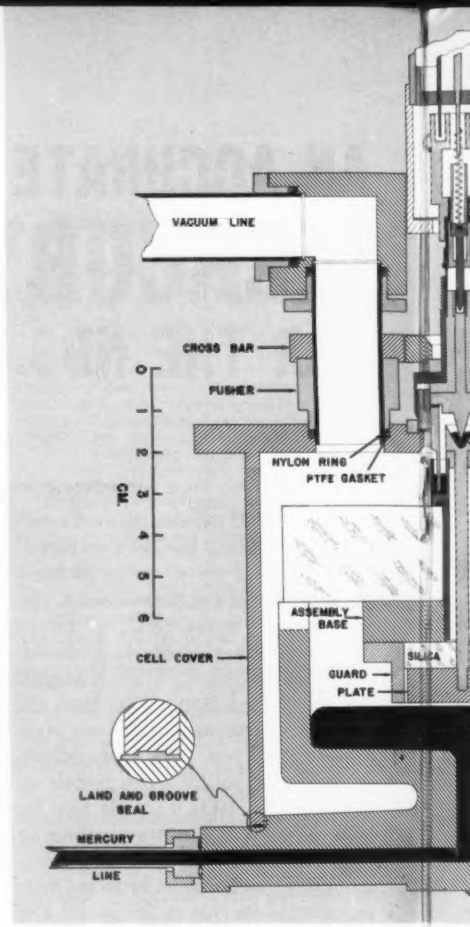
Precise location is provided for the various parts of the manometer by wringing. For this, many surfaces had to be lapped flat, and the position of any wringing component that was rigidly held had to be adjustable, in particular the positions of the cells. The lower cells were wrung to the pedestal surfaces, and the upper cell was wrung to gage blocks, the other end of which was wrung to the upper cell pedestal. All other joints determining the positions of the capacitance plates were also wrung. The cell interior consists of a "meniscus cup," isolated by a deep undercut from the cell base to avoid the effects of flexure. The lip of the meniscus cup was lapped flat to allow wringing of the capacitance plate assembly to it, and the capacitance plate assembly, consisting of five parts, was itself all wrung together.

Each plate and guard assembly is part of a three-terminal capacitor, connected to a ratio arm of a transformer bridge [2] by triaxial cable. The arrangement balances the capacitances between the plates and the menisci of the lower cells in one arm of the bridge against the capacitance between the plate and meniscus of the upper cell plus that of a trimmer capacitor in the other arm. The measurement of the capacitance balance is precise and accurate within 1 part in $10^6$, and the stability of the manometer as determined by the constancy of the trimmer at reference level is within $\pm 7$ nm Hg.

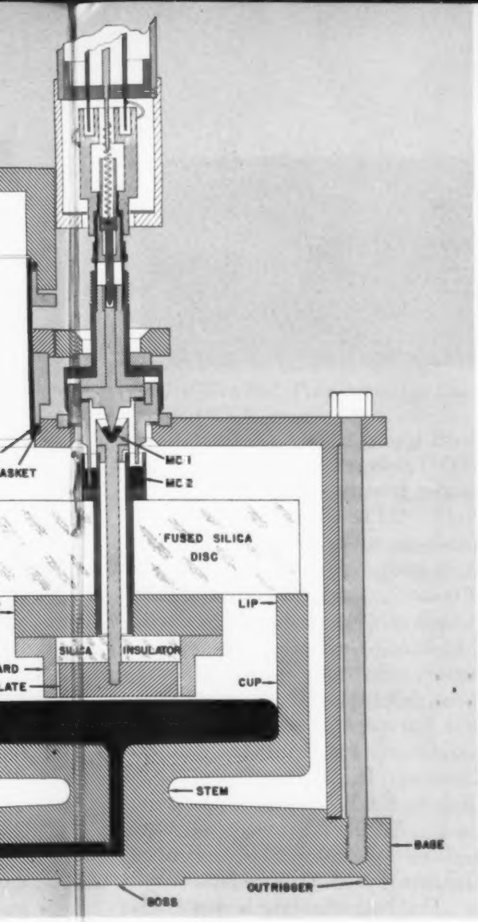
Modular vacuum components were developed for the manometer. Movable and fixed joints, totaling about one hundred in all, were fabricated with PTFE (polytetrafluoroethylene) and PCFE (polytrifluorochloroethylene) seals,[3] which have excellent high vacuum properties and reliability.

The precision and accuracy of the manometer depend upon several other factors, including the design and construction of a special set of rooms. The manometer quarters extend down two stories from the basement level of the main laboratory building, creating a space with an independent, stable foundation. In addition to mechanical isolation, this arrangement gives a nearly constant temperature environment. Both control and measurement of the temperature of the air surrounding the manometer are required. The thermal coefficient of volume expansion of mercury at 20 °C is 181 parts per million per kelvin (with its effect reduced a little by the expansion of the gage blocks); it thus follows that the temperature of the mercury must be known closer than 0.006 °C, to make sure the uncertainty of the density is not increased by more than 1 part per million.

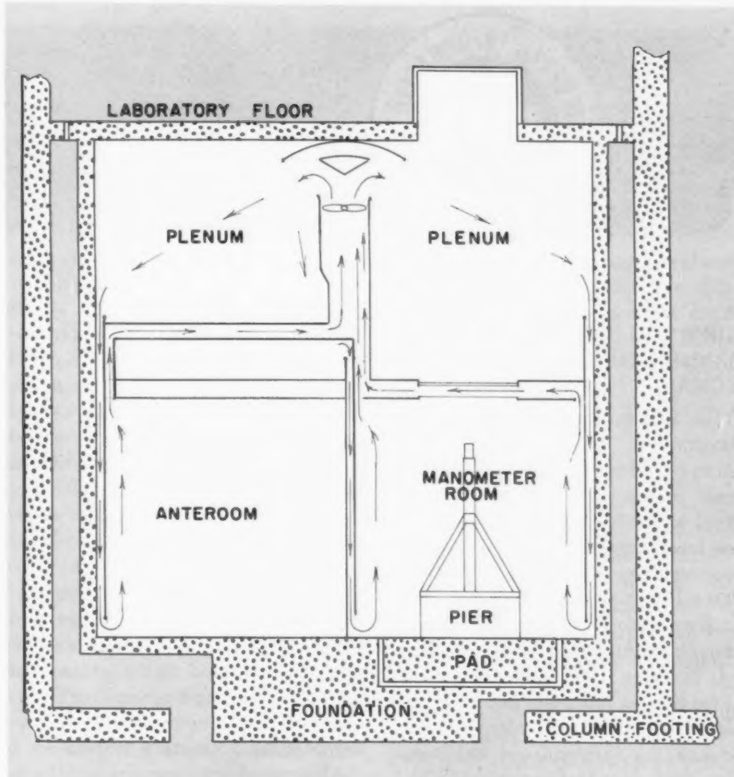
The manometer is located in its room on a "pad" isolated from the foundation by rubber impregnated felt. A concrete pier, 0.86 m square by 0.60 m high, is supported by the pad. Atop the pier is the manometer frame, consisting of a 7.5 cm thick steel plate to which a steel I-beam column and braces are attached. A tube of 3.17 mm bore runs 5 meters from the manometer up to the laboratory and is attached to a 27 liter ballast to help damp out changes of pressure that may occur in the system. The pressure in the ballast is regulated from the output of the capacitance bridge by a heater, which can compensate for change of ballast temperature up to




*Scale drawing of a cross section of the upper cell of the me*
*i.d.) for the meniscus is isolated from the base by a deep cu*
*is lapped flat for wringing. A wrung joint is made between*
*suspends the plate and guard assembly over the meniscus.*
*each part of the plate and guard assembly. The dipping me*
*made at MC1 and MC2, prevent transmission of motion of*
*changes of pressure.*




*per cell of the mercury manometer. A large cup (7.5 cm. base by a deep cut. The boss on the bottom of the base is made between the cup lip and the fused silica disc, which er the meniscus. Other wrung joints are made between v. The dipping mercury contacts to the plate and guard, sion of motion of the top of the cell cover which is flexed by*




*The precision and accuracy of the NBS manometer are partially dependent on the special set of rooms shown in this cross sectional drawing. The rooms extend down two stories from the laboratory floor to a foundation on original earth independent of the building column footings. In addition to mechanical isolation this arrangement gives a nearly constant temperature environment. Further temperature control is maintained by the flow of air from the plenum to the floor below.*

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0.025 °C. Any large change thus will make it impossible to regulate the pressure. It is necessary to allow about 6 hours to attain temperature equilibrium after working in the manometer room; then, the gas pressure is adjusted and the mercury valves are opened by remotely controlled motors.

In operation, a reference level is first established with all three cells wrung directly to the pedestals and the same pressure in each (generally a vacuum). The mercury level is adjusted to give a selected, precise spacing below the capacitance plate of the upper cell. For a measurement, the upper cell is raised and gage blocks of the appropriate total length are wrung between the cell and its pedestal. With the upper cell evacuated, gas is admitted to the lower cells and the volume of mercury in the manometer adjusted until all capacitances are the same as in the reference level measurements. The height of the gage blocks is thus equal to the height of the mercury column needed to balance the desired pressure.

The manometer has been used over the range of $1\times10^4$ to $1.3\times10^5$ pascals to determine pressures, with an error of about 2 parts in $10^6$, and to determine pressure ratios, with an error of about 1.5 parts in $10^6$. It is expected from recent improvements in the exactness of cell dimensions that no greater errors will arise for pressures as low as $2.5\times10^3$ pascals if single gage blocks can be used. The precision of the manometer is nearly constant over its entire range, within about $1.3\times10^{-3}$ pascals.

[1] Guildner, L. A., Stimson, H. F., Edsinger, R. E., and Anderson, R. L., An accurate mercury manometer for the NBS gas thermometer, Metrologia, Vol. 6, No. 1, pp. 1–18 (Jan. 1970).
[2] Guildner, L. A., and Edsinger, R. E., J. Res. Nat. Bur. Stand. (U.S.), **69C**, 13 (1965).
[3] Anderson, R. L., Guildner, L. A., and Edsinger, R. E., Movable and fixed modular vacuum devices with confined fluorocarbon plastic seals, Rev. Sci. Instr. **41**, 1076 (1970).

FIPS NOTES

## EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION (ECMA)

The Federal development and implementation of standards should, where practicable, be consistent with those practices established for national and international use. Articles that have appeared in this column in previous issues of the TECHNICAL NEWS BULLETIN have described the standardization activities nationally through the American National Standards Institute (ANSI)[1] and its Committee X3 on Computers and Information Processing[2] and internationally through the International Organization for Standardization (ISO).[3] There is another organization that has contributed significantly to the successful development of numerous standards in this area, particularly through liaison and support of representatives of national standards bodies in the considerations of ISO. This group known by the short name ECMA (pronounced Ek-ma) is the European Computer Manufacturers Association.

ECMA officially came into being in May 1961 primarily through the efforts of the long standing companies in the European computer field (Compagnie des Machines Bull, IBM World Trade Europe Corporation and International Computers and Tabulators Limited). ECMA, a nonprofit organization composed of members and representatives of European computer companies, was formed as a result of the common recognition of the need for standards. Through the joint efforts of ECMA, ANSI, and the International Electrotechnical Commission (IEC), ISO Technical Committee 97 was established to undertake development of standards in the field of computers and information processing[3] ECMA now is a liaison member of TC 97.

The purpose of the ECMA organization as extracted from its By-Laws is:

"To study and develop, in cooperation with the appropriate national and international organizations, as a scientific endeavor and in the general interest, methods and procedures in order to facilitate and standardize the use of data processing systems.

"To promulgate various standards applicable to the functional design and use of data processing equipment."

The English language, as used in the United Kingdom, is the official language of ECMA. The metric system is used as the basis of measurements.

Organizationally, ECMA is composed of: a General Assembly whose task is to control the association and appoint its management officials; a Coordinating Committee that establishes technical committees and monitors their work; and Technical Committees that are responsible for the development of standards in particular assigned areas. The current president of ECMA is P. J. Davous of Compagnie des Machines Bull. The chief executive is Dara Hekimi who serves as the ECMA Secretary General with offices in Geneva, Switzerland.

The following companies are currently members of ECMA: Allegemeine Elektricitäts – Gesellschaft, AEG–Telefunken (Germany), Burroughs International S.A. (Switzerland), C.I.I. Compagnie Internationale pour l'Information (France), Compagnie des Machines Bull (France), Facit Electronics AB (Sweden), Ferranti Ltd. (United Kingdom), General Electric Information Systems Italia (Italy), Honeywell I.C.C. (United Kingdom), IBM Europe (France), I.C.L. International Computers Ltd. (United Kingdom), Ing. C. Olivetti & C. S.p.A (Italy), I.T.T. Europe Inc. (Belgium), N.C.R. The National Cash Register Company Ltd. (United Kingdom), N.V. Philips–Electrologica (The Netherlands), Siemens Aktiengesellschaft (Germany), UNIVAC Computers (Europe) Ltd. (Italy).

*Associate Members:* Anker–Werke AG (Germany), Badisch Anilin– & Soda–Fabrik AG (Germany), Data Products/Core Memories Ltd. (Ireland), Friden Holland N.V. (The Netherlands), Lamson Paragon Ltd. (United Kingdom), Mastertape (Magnetic) Ltd. (United Kingdom), SAGEM, Societe d'Applications Generals d'Electricite & de Mecanique (France), Tullis Russell & Co. Ltd. (United (Kingdom), Wiggins Teape Research & Development Ltd. (United Kingdom).

Nineteen Technical Working Committees have been established: The numeric designation and title of these are described below. The scope of currently active committees is also listed.

*TC 1, Input and Output Codes*

Scope: Definition of common char-

acter sets (including alphabets, numbers, punctuation marks, special symbols and controls) and their coded representations suitable for input/output media and data transmission in order to facilitate interchange of information between data processing (DP) equipment. To define the implementation of codes on media.

*TC 2 General Programming Languages* (Work completed)

*TC 3, Problem Analysis and Flow Charting* (Work completed)

*TC 4, Optical Character Recognition*

Scope: Definition of a minimum number of character sets legible both to humans and to machines.

Specification of fonts, parameters, measurements and tolerances. Definition of document specification (size limits, ink, position of printed lines, etc.).

*TC 5, ALGOL* (Work completed)

*TC 6, COBOL*

Scope: To survey the implementation and usage of COBOL and to participate in the development and standardization of COBOL languages, taking into account the specific European needs.

*TC 7, Magnetic Ink Character Recognition* (Work completed)

*TC 8, FORTRAN*

Scope: To consider the ISO and ANSI working papers on FORTRAN and subsequent documents to ensure that European requirements are taken into account in order that ECMA members can realize in practice the highest possible degree of interchange of FORTRAN programs.

*TC 9, Data Transmission*

Scope: The definition of common parameters which will facilitate communication within and between data processing systems using transmission links. The preparation of coordinated view-points covering those requirements which are of common interest to both the European computer manufacturers and the telecommunication services.

*TC 10, PL/1*

Scope: To study the PL/1 language and to proceed with standardization of PL/1.

*TC 11, Numerical Control*
(Work completed)

*TC 12, Product Safety*

Scope: To consider national and international safety regulations with a view to establishing appropriate safety recommendations for data processing machines or units so that they are intrinsically safe and safe for operating and maintenance personnel.

*TC 13, Keyboards*

Scope: To define standard layouts for keyboards for the ECMA 7-bit code to be used either locally or remotely with data processing systems, having regard both to existing practices and equipment and to prospective developments in technology and usage.

*TC 14, Paper Sizes*

Scope: To survey and report on form sizes and layouts in use and proposed, and to recommend the fields ripe for standardization.

*TC 15, Data Formats*

Scope: With the primary objective of securing the widest possible compatibility of data, to study its logical and physical structure in general, and the information content of certain commonly occurring items of data and to identify appropriate subjects for standardization of data format.

*TC 16, Disk Packs*

Scope: To identify and standardize the minimum number of parameters necessary to ensure exchangeability of both replaceable disk packs and the information recorded thereon.

*TC 17, Magnetic Tape*

Scope: To identify and standardize the minimum number of parameters necessary to ensure interchangeability of magnetic tapes using appropriate methods of recording and taking account of existing standards.

*TC 18, I/O Interface Committee*

Scope: To investigate the feasibility of standardization of I/O Interface parameters excluding those covered by TC 9 and make proposals.

*TC 19, Magnetic Tape Cassette*

Scope: To identify and standardize the physical properties and the relevant data format of a magnetic tape cassette for digital applications—below the performance range of existing magnetic tape standards—in order to ensure interchangeability.

To date twenty-four ECMA Standards have been published. (Two have been withdrawn.) A list of the ECMA standards and other documents is provided below. These, except for those that have been withdrawn, are available without charge from ECMA Headquarters, Rue du Rhone 114, 1204 Geneva, Switzerland.

## ECMA Standards

ECMA–1 6 Bit Input/Output Code (March 1963), (Withdrawn)

ECMA–2 Subset of ALGOL 60–ECMALGOL (April 1965)

ECMA–3 CMC7 Printed Image Specification, 2nd Edition (September 1966)

ECMA–4 Flow Charts, 2nd Edition (September 1966)

ECMA–5 Data Interchange on 7 Track Magnetic Tape, 2nd Edition (December 1966)

ECMA–6 7 Bit Input/Output Coded Character Set, 2nd Edition (June 1967)

ECMA–7 7 Bit Code in Punched Cards (April 1965), (Withdrawn)

ECMA–8 Nominal Character Dimensions of the Numeric OCR–A Font (April 1965)

ECMA–9 FORTRAN (April 1965)

ECMA–10 Data Interchange on Punched Tape (November 1965)

ECMA–11 Alphanumeric Character Set OCR–B for Optical Recognition (November 1965)

ECMA–12 Data Interchange on 9 Track Magnetic Tape at 31.5 bit per mm (800 bpi) (November 1967)

ECMA–13 Magnetic Tape Labelling (November 1967)

ECMA–14 Rules for the Definition of 4 Bit Sets Derived from the ECMA 7 Bit Coded Character Set (November 1967)

ECMA–15 Printing Specifications

for Optical Character Recognition (May 1968)

ECMA–16 Basic Mode Control Procedures for Data Communications Systems using the ECMA 7 Bit Code (May 1968)

ECMA–17 Graphic Representation of the Control Characters of the ECMA 7 Bit Coded Character Set for Information Interchange (November 1968)

ECMA–18 Printing Line Position on Single Line Documents (November 1968)

ECMA–19 Coding of Character Sets for MICR and OCR (June 1969)

ECMA–20 Implementation of the ECMA 7 Bit Coded Character Set on Punched Cards (June 1969)

ECMA–21 Character Positioning on OCR Journal Tape (June 1969)

ECMA–22 Electrical Safety Requirements for Data Processing Machines (June 1969)

ECMA–23 Keyboards Generating the Code Combinations of the Characters of the ECMA 7 Bit Coded Character Set (June 1969)

ECMA–24 Code Independent information Transfer (An extension to the Basic Mode Transmission Control Procedures) (December 1969)

### Other Documents

Drawings of the ECMA Light Transmission Meter (April 1965)

Comments and Notes on the Standard ECMA–3 for the Printed Image of the CMC 7 Font, 2nd Edition (February 1967)

A Set of I/O Procedures for ECMALGOL (January 1967)

Notes on instruments and Measuring Methods related to the ECMA Standard for Printing Specifications for OCR (ECMA–15) (August 1968)

Recommended OCR Paper Specification (March 1970)

Another publication that contains information about the ECMA organization, its rules, and list of members and representatives on technical committees is the ECMA MEMENTO. This document is available at no charge from ECMA Headquarters.

## NEW FIPS TASK GROUP ESTABLISHED TO DEVELOP GUIDELINES FOR DESCRIBING DATA INTERCHANGE FORMATS

In recognition of the need to improve the descriptions of data formats that are commonly employed in interchange, the NBS Center for Computer Sciences has recently authorized the formation of Federal Information Processing Standards Task Group 8 (FIPS TG–8). The scope of the new group is to develop guidelines for describing in man-to-man terms (documentation) the data formats involved in information interchange. Harry S. White, Jr. of the NBS Office of Information Processing Standards has been designated as the task group chairman.

The task group will have the following work program:

1. To identify the types of formats that need to be described. (Priority to be given to those formats currently used in punched card and magnetic tape interchange.)

2. To identify the criteria that should be satisfied by the guidelines.

3. To obtain, to the extent practicable, material from information processing activities concerning their current procedures for describing data formats.

4. To evaluate current procedures in terms of the criteria to determine if any current practice(s) meet(s) the requirements in order to determine if further development is necessary or whether existing procedures can be used.

5. To advise NBS concerning Federal input to activities of a similar nature being conducted under the sponsorship of the American National Standards Institute.

The following definition was provided the Task Group in order to clarify the work involved:

Description of Information Interchange Formats—the documentation used by the prescriber or sender of formatted data to inform the furnisher or receiver of the data what is contained in the interchange. This documentation provides:

1. For the identification and definition of each data element represented in the fields of the interchange record.

2. Descriptions of the representation of each data element.

3. Description of the location of each field within the interchange record.

4. Other factors as required such as physical characteristics of the interchange media, file structures, and labelling conventions.

The format description (documentation) precedes the interchange of the machine sensible data. It is not in the form of a data definition language that is processable by a compiler or other form of language manipulator. The Guideline will not prescribe the format nor the use and content of the data format. Its primary purpose is to provide an effective means for describing the data as determined by the interchange parties.

It is expected that membership on the Task Group will be composed of technical specialists from those government departments and agencies that commonly interchange data with other government activities or the public. The Department of Health, Education, and Welfare, Post Office Department, General Services Administration, NASA and the Internal Revenue Service of the Treasury Department have indicated support of Task Group effort by providing technical specialists. Others interested in contributing to this work may contact Mr. White, the Task Group Chairman, Office of Information Processing Standards, National Bureau of Standards, Washington, D.C. 20234.

[1] See Voluntary national standards for computers and information processing, FIPS NOTES, Nat. Bur. Stand. (U.S.), Technical News Bulletin 54, No. 4, 85–87 (April 1970).

[2] See Reorganization of ANSI standards committee X3, FIPS NOTES, Nat. Bur. Stand. (U.S.), Technical News Bulletin 54, No. 5, 100–102 (May 1970).

[3] See International standards for information processing, FIPS NOTES, Nat. Bur. Stand. (U.S.), Technical News Bulletin 54, No. 2, 40–42 (February 1970).

# UTC TIME SCALE
## TO CHANGE IN 1972

ON JANUARY 1, 1972, THE TIME SCALE known as UTC (Coordinated Universal Time, also called GMT, or Greenwich Mean Time), the most commonly used time scale around the world, will be slightly altered.* The present offset from atomic time will be eliminated, and step adjustments will be made in increments of 1 second instead of 0.1 second. Thus, after January 1, 1972, UTC will accumulate time at the same rate as International Atomic Time (IAT), except that whole-second step adjustments, called leap-seconds, will be made as needed to maintain approximate agreement with an earth-rotation-based time scale. UTC is broadcast by many stations, including WWV, operated by the Bureau's Boulder laboratories, and is the basis for standard time in the United States.

The change will affect only users of precise frequency generators and timekeeping equipment, who probably will have to adjust their equipment or operations. These users include radio and television stations, scientific laboratories, electric-power companies, manufacturers of electronic equipment, and perhaps the makers of navigation and radar equipment. Groups which use precise timing instruments for the sole purpose of synchronizing their activities will not necessarily be affected.

*Final approval of the Jan. 1, 1972, date is expected at the next meeting of the International Radio Consultative Committee, to be held in Geneva Feb. 1971.

UTC, at present, is a compromise time scale arrived at by international agreement through the International Radio Consultative Committee. It is an atomic time that has been adjusted, or offset, in rate to approximately follow a time scale based on the rotation of the earth. The offset now consists of a continuous retardation of 30 parts per billion. In addition, step adjustments of 0.1 second are made whenever needed to keep UTC within 0.1 second of a time scale based on the rotation of the earth.

The need for the change arises from the fact that today's atomic clocks are very constant and provide a time scale that is much more uniform than the scale provided by the earth's rotation. In fact, a time scale based on the earth's rotation will vary almost a second per year, compared to the time scales generated by atomic clocks. That much variation cannot be tolerated by many technical and scientific projects, and so atomic clocks are used to generate our time scales today.

*Charles Snider (left) and David Glaze operate the cesium beam atomic clock used to control the time signals broadcast by NBS radio stations.*

However, even though the time scales used throughout the world are generated by these atomic clocks, it is convenient to coordinate the atomic time with the time indicated by the rotation of the earth. This is done so that navigators and others can use clocks to determine their position on earth.

At present, this coordination between the varying rate of rotation of the earth and the constant rate of the atomic clock is done by slowing down the atomic clock rate by a certain fraction, and by substracting or adding pieces of a second several times a year. All these adjustments cause errors for the scientists and technicians involved.

The new system will be much simpler; the atomic clock rate will not be slowed down at all, and instead of adding or substracting a fraction of a second every few months, everyone will add or substract a whole second once in 12 to 18 months. Naturally, if your clocks lose or gain more than one second in a year, you won't have to worry about these tiny adjustments.

The one-second adjustment, or leap-second, is very similar in concept to adding an extra day during leap-years. The leap-year was invented to ensure that the seasons would always begin on the same dates, and is necessary because there is not a whole number of days in the year. Similarly, there is not a whole number of seconds in a day; in fact, there is not even the *same* number of seconds in each day. The fraction "left over" each day would eventually add up to make our clocks out of step with the sun. The leap-second will be used, then, to prevent this from happening.

The standard time and frequency radio stations maintained by various

*Continued on p. 82*

# NSRDS NEWS

*The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.*

## ORGANIZED EVALUATION OF RATE DATA

At a symposium session on "Recent Advances in Kinetics and Catalysis," held during the 63rd Annual Meeting of the American Institute of Chemical Engineers, Nov. 29–Dec. 3, 1970 in Chicago, David Garvin, Director of the NBS Chemical Kinetics Information Center, presented a paper entitled, "Organized Evaluation of Rate Data-Progress and Problems." Because this paper reviews problems facing all data evaluators, the following excerpts are presented:

The disciples of physics and chemistry provide two of the major tools used in the design of chemical process systems. These are thermochemical and rate data. The preferred form for these data in the view of the ultimate user is a set of tables containing carefully evaluated recommended quantitative values. Somebody must prepare the tables. Our concern here is what has been accompished in the tabuation of data on chemica kinetics and how this work is being encouraged . . .

### Major Programs that Promote the Evaluation of Rate Data

Although the need for the evaluation of data is recognized in the technical community, this type of work is not viewed as a glamorous activity. It must be promoted and supported if it is to compete with other scientific research. Three national programs now do this: here in the U.S.A., in the U.K. and in the U.S.S.R. In addition there is an international effort being made by the Committee on Data for Science and Technology (CODATA) of the International Council of Scientific Unions. Only their programs in the area of chemical kinetics are described here.

A. The National Standard Reference Data System is the principal program in the U.S.A. It is administered by the Office of Standard Reference Data, which is part of the National Bureau of Standards. The charter of this office is to carry out the terms of the Standard Reference Data Act of 1968. The act authorizes the Secretary of Commerce "to provide or arrange for the collection, compilation, critical evaluation, and publication of standard reference data" and, "to prescribe . . . such standards, criteria and procedures for the preparation and publication of standard reference data as may be necessary . . ." [1]

The approach taken by the Office of Standard Reference Data has been to emphasize the first of these missions. Their plan has three important features:

1. *Emphasis on the properties of well characterized materials.* This means, in general, emphasis on physics and chemistry. For kinetics it means emphasis on areas in which there is a large body of data and where evaluated data could be of high utility.

2. *Data reviews for topics of limited scope.* These are reviews in depth, written by experts in the subjects, that have one distinguishing feature: The authors are asked to emphasize the measured data, develop 'best values' and, where necessary, indicate what future work is needed. Thirty one NSRDS reviews have been published, five of which are of immediate interest of kineticists.

These are: a compilation of gas phase rate data for bimolecular reactions, an evaluation of data on over 500 unimolecular reactions, two monographs on specific topics: hydrogenation of ethylene and reactions among neutral oxygen species, and a table of bond strengths. Without doubt other NSRDS publications will also be of interest to the same audience. They are announced regularly in NBS serial publications.[2]

The emphasis in the NSRDS program has been on gas phase reactions. This is not surprising in view of the importance of chemical propulsion, of atmospheric chemistry and the improvement of gas kinetics techniques during the decade.

3. *Information Analysis Centers.* These collect, compile and evaluate data pertinent to a particular field. In addition, they assist the authors of the critical reviews by providing extensive bibliographical services, and also respond to requests for information from the public. Four centers serve the needs of kineticists. All told there are 26 centers connected with the NSRDS program.

The Information Analysis Center is a relatively new feature on the technical landscape. They are data and bibliographic sources. Those supported by the U.S. Government are

listed in a directory published by the Committee on Scientific and Technical Information.[3] An even larger source of information about data resources is the National Referral Service for Science and Technology.[4] World-wide activities have been compiled by CODATA.[5]

B. The data program in the United Kingdom is managed by the Office of Scientific and Technical Information (OSTI). It has encouraged research workers to review and codify the data in their specialties and has supported an evaluation center, the High Temperature Reaction Rate Data Group at the University of Leeds. This group has produced, in the past two and one-half years, five reports containing detailed evaluations of 39 reactions in the hydrogen-oxygen and nitrogen-oxygen systems. These reports should be consulted by any research workers concerned with detailed mechanisms of gas phase reactions and modeling of complex systems. It is not yet clear that they have received as wide a distribution in this country as they deserve.

C. The State Service for Standard and Reference Data (GSSSD) is the supervisory organization in the U.S.S.R. It recently has organized a Commission on Compilation of Rate Data under the leadership of Academician V. N. Kondratiev. This body has established eleven working groups that have the task of coordinating research work in quantitative chemical kinetics and are responsible for the compilation and critical evaluation of reaction rate data. . . The first kinetics data publication from the U.S.S.R. under this general program is a handbook of gas phase rate data by Professor Kondratiev.

D. In 1969 the Committee on Data for Science and Technology established a Task Group on Data for Chemical Kinetics. The chairman of this group is Professor S. W. Benson. It has members in the U.K., France, Federal Republic of Germany, U.S.S.R., Japan, and the U.S.A. It has been asked to undertake a comprehensive survey of world-wide data compilation activities to find out what data not now being compiled are needed, and to prepare a workable plan that could be carried out, on a cooperative basis, on an international scale. This is a far from modest charge. It will require hard work over a long period of time. But the gains could be great. At present there is considerable duplication of effort in the national programs in the face of an almost infinite amount of work to be done.

The Task Group is now surveying the current data activities in kinetics. What it has found to date should surprise no one. First, there are the major compilation/evaluation activities supported by national programs section. Second, there is a much larger review effort leading to the preparation of articles in review journals, monographs, and encyclopedias. Although no retrospective study has been undertaken, this review effort appears to have grown sharply in the past few years.

Two problems stand out concerning this review activity. First, the Task Group needs to know what is being planned, and in particular whether the reviews will include tables of data and evaluations. It is not easy to obtain the comprehensive picture of this effort that the Task Group needs. May I encourage authors of reviews to outline their plans? Letters to members of the Group or to the Chemical Kinetics Information Center will be of great assistance. Second, the entire technical community must face the question of how to encourage authors of reviews to pay more attention to the measured data and the evaluation of it. We need to promote this because of the vast amount of material that should be codified. How can we do this, in the face of the almost universal tendency of reviewers either simply to state what has been done, or to use the data as clues to or as support for generalization?

## The Future

The evaluations and compilations that are likely to appear in the near future can be stated with confidence. They reflect decisions made in the past. A combined list based on the current activities of the national programs is given in Table 1. These represent a continuation of present work, not a new departure.

*Table 1. Rate evaluations planned for the near future. (Based on reports from the various national programs.)*

| | |
|---|---|
| **1. GAS PHASE REACTIONS** | |
| a. Light molecule reactions | |
| $H + H + M \rightleftarrows H_2 + M$ | $NO + NO + O_2 \rightleftarrows NO_2 + NO_2$ |
| $H + O + M \rightleftarrows OH + M$ | $O + N_2 + M \rightleftarrows N_2O + M$ |
| $H + NO + M \rightleftarrows HNO + M$ | $N + NO + M \rightleftarrows N_2O + M$ |
| $H + NH_2 + M \rightleftarrows NH_3 + M$ | $NO_2 + NO_2 + M \rightleftarrows N_2O_4 + M$ |
| $H + SO_2 + M \rightleftarrows HSO_2 + M$ | $NO + NO \rightleftarrows N_2 + O_2$ |
| $H + HS + M \rightleftarrows H_2S + M$ | $NO + NO \rightleftarrows N_2O + O$ |
| $H + CH_3 + M \rightleftarrows CH_4 + M$ | $NO_2 + O \rightleftarrows NO + O_2$ |
| $H + C_2H_5 + M \rightleftarrows C_2H_6 + M$ | $C + O + M \rightleftarrows CO + M$ |
| $N + N + M \rightleftarrows N_2 + M$ | $SO + O + M \rightleftarrows SO_2 + M$ |
| $N + O + M \rightleftarrows NO + M$ | $SO + O_2 + M \rightleftarrows SO_3 + M$ |
| $NO + O + M \rightleftarrows NO_2 + M$ | $SO_2 + O + M \rightleftarrows SO_3 + M$ |
| b. Abstraction reactions of OH with $CH_4$, $C_2H_2$, $C_2H_4$, $C_2H_6$, O, $H_2O_2$, H, $NH_3$, $H_2CO$, $HNO_3$, HNO, and $CH_3$. | |
| c. Addition reactions of atoms and radicals to multiple bonds. | |
| d. Dissociation and recombination reactions of $F_2$ and $Cl_2$. | |
| e. Supplemental Compilation of rates of abstraction reactions. | |
| **2. SOLUTION REACTIONS** | |
| a. Homolytic liquid phase reactions. | |
| b. Hydroxyl radical reactions in water. | |

Also it is easy to suggest that we do not now need more broad gauge *compilations* of gas phase rate data. The initial spurt of activity has produced enough of these. Perhaps supplements will be desirable, but a general retabulation should be put off for five years.

What can and should be done are difficult matters. A rapid, comprehensive evaluation of data from all branches of chemical kinetics is highly unlikely. None of the national programs appears to command the resources needed, even if duplication is avoided. Selective attack will continue to be the tactic employed. What attacks should be made? I suggest that two criteria should be given equal weight: what is possible, and what will be useful now.

1. *The possible.* In order for data to be evaluated there must be a body of material that can be compared. More likely than not this does not exist for reaction rates. *Few reactions are studied repeatedly.* For example, among 215 reactions of hydrogen atoms listed by Kondratiev, there are 125 with only one reference cited. Thirty-seven have two references. There are valuations for twenty-two of the multiple citation reactions. Any evaluator hesitates to tackle the rest. But I doubt that we can afford to ignore these lightly studied reactions. A remedy is to encourage rate evaluations that emphasize quality judgments on the reliability of isolated studies and correlations of similar systems above the intercomparison of replicates. This implies that a much lower level of precision must be acceptable for reviewed rate data than is expected for evaluated thermochemical properties.

2. *The useful.* While the decision on the possible is up to the experts in the research disciplines, that on utility is shared between the users and those experts. From experience with the Chemical Kinetics Information Center, I doubt that users are knowledgeable about their needs other than for a spot answer to an immediate question. An evaluation program cannot be run on the basis of random requests, although a bibliographic service can be. If evaluation programs are to give priority to immediate needs, there must be careful statements of these needs for kinetics data. User groups, of which chemical engineers are a prime example, should organize to make their wants known.

The possible and the useful pose a potential conflict. The expert is understandably reluctant to tabulate and recommend rates on the basis of sketchy data. He knows that what he tabulates will be taken as received truth, and that his peers will consider his work to be sloppy unless well documented. The user needs data and finds that the probability of getting evaluated data is very low. Can this be resolved? I think it can in terms of a different kind of evaluation effort.

This is the problem-oriented multidiscipline interpretive compilation. This is a work geared to the solution of a major problem, as for example, the understanding of the chemistry of environmental pollution. For this example the pertinent items are physical properties, thermodynamic functions, photochemistry, spectra, and rate data. A problem-oriented collection could have as its goals (a) listings of the best available data with statements about their reliability, (b) listings of potentially important processes for which data are not available, and (c) guesses to fill the gap, whenever possible. The last point is important. The expert, not the user, should guess.

These problem-oriented compilations must be viewed as ephemeral documents to be used as aids in solving important problems. But even so, they could be a major, timely contribution and an effective method for research diciplines to transfer their accumulated expertise to their allied technologies.

[1] Public Law 90–396, July 11, 1968 (82 Stat. 339) U.S.A.

[2] Address inquiries: Information Services, Office of Standard Reference Data, National Bureau of Standards, Washington, D.C. 20234.

[3] Committee on Scientific and Technical Information, "Directory of Federally Supported Information Analysis Centers" (National Technical Information Service, Springfield, Virginia 1970) PB 189 300.

[4] National Referral Center for Science and Technology, Library of Congress, Washington, D.C. This is the central "switching center" for identifying sources of information. Directories published periodically.

[5] Committee on Data for Science and Technology, "International Compendium of Numerical Data Projects" (Springer-Verlag, New York 1969.)

**UTC TIME SCALE** *Continued*

countries will cooperate with the International Time Bureau in broadcasting the new time scale and in making the adjustments simultaneously. The adjustments should not be needed more than once in 12 to 18 months, and will be made preferably on January 1 or July 1. To provide a traditional service to navigators and astronomers, who need earth-related time, these stations will broadcast information concerning the difference between the transmitted time and astronomical time (UTI). The difference will not be more than 0.7 second, and will probably be broadcast with a resolution of 0.1 second.

In the United States, therefore, the NBS standard broadcast services of WWV, WWVH, WWVL, and WWVB will be changed to have zero offset from nominal in their carrier and modulation frequencies and time signals. At 00 hours on January 1, 1972, UTC will be reset a fraction of a second, sufficient to give the new UTC scale an initial difference of an integral number of seconds (probably 10.000 seconds late) with respect to IAT as maintained by the International Time Bureau. UTC is now about 9 seconds late, and during the next year the difference will probably grow to about 10 seconds; thus, the reset should be only a few hundred milliseconds. Thereafter, the difference between UTC and IAT will always be an integral number of seconds.

# CONFERENCE & PUBLICATION *Briefs*

## THE FIRST SYMPOSIUM ON THE USE OF COMPUTERS FOR ENVIRONMENTAL ENGINEERING RELATED TO BUILDINGS

The First Symposium on the Use of Computers for Environmental Engineering related to Buildings was held November 30–December 2, 1970, at the Bureau. The meeting brought together scientists and engineers throughout the world for the exchange of information on problems encountered and advances in the state-of-the-art in this rapidly expanding field. The Symposium was jointly sponsored by NBS, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE), and Automated Procedures for Engineering Consultants, Inc. (APEC). More than 375 scientists and engineers, representing Governmental, academic, and industrial interests were in attendance for approximately 60 technical papers concerning the utilization of computer technology in building environmental engineering. A truly international aspect was given to the Symposium by attendees from France, Japan, Canada, Scotland, The Netherlands, Sweden, Denmark, England, The Federal Republic of Germany, Finland, Argentina, Belgium, Switzerland, The Republic of South Africa, and Australia.

The three day Symposium featured a plenary session, nine formal technical sessions, a forum on computerized control technology, and tours of selected NBS facilities. The technical sessions covered the following areas: Computer Graphics; Modeling, Design, Survey and Linear Programming; Analog Computation and Time Sharing; Energy Load Calculations; Temperature Simulation Calculations; Energy Calculations, Air Duct Systems; Solar Effects and Convection; Air Conditioning Calculations and Weather Data; and Wall Conduction and Thermal Load Simulation.

P. R. Achenbach opened the Plenary Session and introduced Dr. F. K. Willenbrock, Director of the NBS Institute for Applied Technology, who welcomed attendees on behalf of the Bureau, and Bruce Graham, Skidmore, Owings and Merrill, who delivered the Keynote Speech. Frank Bridgers, President of ASHRAE, was Master of Ceremonies for the banquet program which featured an invited address by Sital Daryanani of Syska and Hennessy, Inc., entitled "Computers and the Building Industry." Following Mr. Daryanani's address, an impressive computer-generated color movie describing air movement in an enclosed space was shown. This movie was the result of work done by J. E. Fromm, IBM Corporation.

The Symposium concluded with tours of the NBS facilities. Results of current NBS research on graphical display systems and their use as an interface between the computer and its users were displayed. Also toured were Building Research Division facilities for structural research, a controlled environment room large enough to contain whole buildings, and a scale model developed for studying air convection in rooms.

Symposium proceedings will be formally published by NBS; availability will be announced by ASH RAE and NBS.

## ANALYTICAL CHEMISTRY

The vital role of analytical chemistry in the solution of problems of current national importance will be the theme of the 24th Annual Summer Symposium on Analytical Chemistry to be held at the Bureau June 16–18, 1971. Sponsors for the Symposium are the American Chemical Society's Division of Analytical Chemistry and the NBS Analytical Chemistry Division. Previous symposia have focused on specific analytical competences; in contrast, the 1971 Summer Symposium will be concerned with broad analytical problems, including unsolved research problems in major areas of national concern, and the role of the analytical chemist in the solution of these problems. This joint meeting of analytical chemists with specialists in the subject matter areas should provide important insights into measurement areas where modern analytical chemistry can make major contributions.

The tentative program of invited lecturers and round table discussions will include such topics as the health field, including biomedical research and clinical medicine; environmental pollution; and other areas of science and technology, such as materials research, oceanography, and space.

For further information contact:
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Washington, D.C. 20234

## SCHEDULED NBS-SPONSORED CONFERENCES

*Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.*

**Flow—Its Measurement and Control in Science and Industry.** May 10–14.

Also it is easy to suggest that we do not now need more broad gauge *compilations* of gas phase rate data. The initial spurt of activity has produced enough of these. Perhaps supplements will be desirable, but a general retabulation should be put off for five years.

What can and should be done are difficult matters. A rapid, comprehensive evaluation of data from all branches of chemical kinetics is highly unlikely. None of the national programs appears to command the resources needed, even if duplication is avoided. Selective attack will continue to be the tactic employed. What attacks should be made? I suggest that two criteria should be given equal weight: what is possible, and what will be useful now.

1. *The possible.* In order for data to be evaluated there must be a body of material that can be compared. More likely than not this does not exist for reaction rates. *Few reactions are studied repeatedly.* For example, among 215 reactions of hydrogen atoms listed by Kondratiev, there are 125 with only one reference cited. Thirty-seven have two references. There are valuations for twenty-two of the multiple citation reactions. Any evaluator hesitates to tackle the rest. But I doubt that we can afford to ignore these lightly studied reactions. A remedy is to encourage rate evaluations that emphasize quality judgments on the reliability of isolated studies and correlations of similar systems above the intercomparison of replicates. This implies that a much lower level of precision must be acceptable for reviewed rate data than is expected for evaluated thermochemical properties.

2. *The useful.* While the decision on the possible is up to the experts in the research disciplines, that on utility is shared between the users and those experts. From experience with the Chemical Kinetics Information Center, I doubt that users are knowledgeable about their needs other than for a spot answer to an immediate question. An evaluation program cannot be run on the basis of random requests, although a bibliographic service can be. If evaluation programs are to give priority to immediate needs, there must be careful statements of these needs for kinetics data. User groups, of which chemical engineers are a prime example, should organize to make their wants known.

The possible and the useful pose a potential conflict. The expert is understandably reluctant to tabulate and recommend rates on the basis of sketchy data. He knows that what he tabulates will be taken as received truth, and that his peers will consider his work to be sloppy unless well documented. The user needs data and finds that the probability of getting evaluated data is very low. Can this be resolved? I think it can in terms of a different kind of evaluation effort.

This is the problem-oriented multidiscipline interpretive compilation. This is a work geared to the solution of a major problem, as for example, the understanding of the chemistry of environmental pollution. For this example the pertinent items are physical properties, thermodynamic functions, photochemistry, spectra, and rate data. A problem-oriented collection could have as its goals (a) listings of the best available data with statements about their reliability, (b) listings of potentially important processes for which data are not available, and (c) guesses to fill the gap, whenever possible. The last point is important. The expert, not the user, should guess.

These problem-oriented compilations must be viewed as ephemeral documents to be used as aids in solving important problems. But even so, they could be a major, timely contribution and an effective method for research diciplines to transfer their accumulated expertise to their allied technologies.

[1] Public Law 90–396, July 11, 1968 (82 Stat. 339) U.S.A.

[2] Address inquiries: Information Services, Office of Standard Reference Data, National Bureau of Standards, Washington, D.C. 20234.

[3] Committee on Scientific and Technical Information, "Directory of Federally Supported Information Analysis Centers" (National Technical Information Service, Springfield, Virginia 1970) PB 189 300.

[4] National Referral Center for Science and Technology, Library of Congress, Washington, D.C. This is the central "switching center" for identifying sources of information. Directories published periodically.

[5] Committee on Data for Science and Technology, "International Compendium of Numerical Data Projects" (Springer-Verlag, New York 1969.)

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**UTC TIME SCALE** *Continued*

countries will cooperate with the International Time Bureau in broadcasting the new time scale and in making the adjustments simultaneously. The adjustments should not be needed more than once in 12 to 18 months, and will be made preferably on January 1 or July 1. To provide a traditional service to navigators and astronomers, who need earth-related time, these stations will broadcast information concerning the difference between the transmitted time and astronomical time (UTI). The difference will not be more than 0.7 second, and will probably be broadcast with a resolution of 0.1 second.

In the United States, therefore, the NBS standard broadcast services of WWV, WWVH, WWVL, and WWVB will be changed to have zero offset from nominal in their carrier and modulation frequencies and time signals. At 00 hours on January 1, 1972, UTC will be reset a fraction of a second, sufficient to give the new UTC scale an initial difference of an integral number of seconds (probably 10.000 seconds late) with respect to IAT as maintained by the International Time Bureau. UTC is now about 9 seconds late, and during the next year the difference will probably grow to about 10 seconds; thus, the reset should be only a few hundred milliseconds. Thereafter, the difference between UTC and IAT will always be an integral number of seconds.

# CONFERENCE & PUBLICATION *Briefs*

### THE FIRST SYMPOSIUM ON THE USE OF COMPUTERS FOR ENVIRONMENTAL ENGINEERING RELATED TO BUILDINGS

The First Symposium on the Use of Computers for Environmental Engineering related to Buildings was held November 30–December 2, 1970, at the Bureau. The meeting brought together scientists and engineers throughout the world for the exchange of information on problems encountered and advances in the state-of-the-art in this rapidly expanding field. The Symposium was jointly sponsored by NBS, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE), and Automated Procedures for Engineering Consultants, Inc. (APEC). More than 375 scientists and engineers, representing Governmental, academic, and industrial interests were in attendance for approximately 60 technical papers concerning the utilization of computer technology in building environmental engineering. A truly international aspect was given to the Symposium by attendees from France, Japan, Canada, Scotland, The Netherlands, Sweden, Denmark, England, The Federal Republic of Germany, Finland, Argentina, Belgium, Switzerland, The Republic of South Africa, and Australia.

The three day Symposium featured a plenary session, nine formal technical sessions, a forum on computerized control technology, and tours of selected NBS facilities. The technical sessions covered the following areas: Computer Graphics; Modeling, Design, Survey and Linear Programming; Analog Computation and Time Sharing; Energy Load Calculations; Temperature Simulation Calculations; Energy Calculations, Air Duct Systems; Solar Effects and Convection; Air Conditioning Calculations and Weather Data; and Wall Conduction and Thermal Load Simulation.

P. R. Achenbach opened the Plenary Session and introduced Dr. F. K. Willenbrock, Director of the NBS Institute for Applied Technology, who welcomed attendees on behalf of the Bureau, and Bruce Graham, Skidmore, Owings and Merrill, who delivered the Keynote Speech. Frank Bridgers, President of ASHRAE, was Master of Ceremonies for the banquet program which featured an invited address by Sital Daryanani of Syska and Hennessy, Inc., entitled "Computers and the Building Industry." Following Mr. Daryanani's address, an impressive computer-generated color movie describing air movement in an enclosed space was shown. This movie was the result of work done by J. E. Fromm, IBM Corporation.

The Symposium concluded with tours of the NBS facilities. Results of current NBS research on graphical display systems and their use as an interface between the computer and its users were displayed. Also toured were Building Research Division facilities for structural research, a controlled environment room large enough to contain whole buildings, and a scale model developed for studying air convection in rooms.

Symposium proceedings will be formally published by NBS; availability will be announced by ASH RAE and NBS.

### ANALYTICAL CHEMISTRY

The vital role of analytical chemistry in the solution of problems of current national importance will be the theme of the 24th Annual Summer Symposium on Analytical Chemistry to be held at the Bureau June 16–18, 1971. Sponsors for the Symposium are the American Chemical Society's Division of Analytical Chemistry and the NBS Analytical Chemistry Division. Previous symposia have focused on specific analytical competences; in contrast, the 1971 Summer Symposium will be concerned with broad analytical problems, including unsolved research problems in major areas of national concern, and the role of the analytical chemist in the solution of these problems. This joint meeting of analytical chemists with specialists in the subject matter areas should provide important insights into measurement areas where modern analytical chemistry can make major contributions.

The tentative program of invited lecturers and round table discussions will include such topics as the health field, including biomedical research and clinical medicine; environmental pollution; and other areas of science and technology, such as materials research, oceanography, and space.

For further information contact:

Dr. R. A. Durst
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National Bureau of Standards
Washington, D.C. 20234

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**Flow—Its Measurement and Control in Science and Industry.** May 10–14.

Cosponsors: American Institute of Physics; American Society of Mechanical Engineers; Instrument Society of America. Contact: V. J. Giardina, Instrument Society of America, 400 Stanwix Street, Pittsburgh, Pa. 15222. To be held in Pittsburgh, Pa.

**Fourth Joint Meeting of Operations Researchers.** May 24–26. Sponsors: College on Logistics of the Institute for Management Sciences (TIMS); Mathematical Society of America; American Society for Cybernetics; American Society for Public Administration; Association for Computing Machiner; Operations Research Society of America. Contact: Lloyd Burden (NBS Technical Analysis Division).

**Fifth Symposium on Temperature Measurement and Control in Science and Industry.** June 21–24. Cosponsors: American Institute of Physics; Instrument Society of America. Contact: H. H. Plumb (NBS Heat Division).

**NBS Measurement Seminars, 1971 Series.** Two- to four-day courses on measurement and calibration problems. Attendance limited. See September 1970 *Technical News Bulletin* for detailed information.

## FUEL CONSERVATION

To help homeowners reduce their fuel bills, to help conserve energy sources, and to help reduce environmental pollution, NBS and the Office of the Special Assistant to the President for Consumer Affairs have prepared a booklet on *7 Ways to Reduce Fuel Consumption in Household Heating*. Briefly, the seven ways are: weatherstrip; use storm windows; insulate; maintain an efficient heating plant; close draperies; control air leakage into attics; and make wise use of utilities (by turning off unneeded lights, turning down the thermostat at night, etc.). This booklet, well illustrated and written for easy understanding, is available free of charge from the President's Committee on Consumers Interests, Washington, D.C. 20506.

## NTIS SALES DESKS

A National Technical Information Service (NTIS) Sales Desk is now located in the main lobby of the Commerce Department building, Washington, D.C. All NTIS products and services are available at this location, including individual documents, renewals of subscriptions to NTIS publications, prepaid coupons and NTIS Deposit Accounts.

NTIS also maintains a Sales Desk at their Springfield, Virginia, facility. Customers wishing to use either sales desk should call the NTIS Sales Desk at Springfield, Virginia, 321–8543, to place their orders in advance. Depending upon what document or service is ordered and its availability, the NTIS pick up service can generally be provided in one day.

## SEMINAR ON LOW FREQUENCY ELECTRICAL STANDARDS

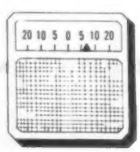
A 3-day seminar on the accurate measurement of electrical quantities and the calibration of electrical standards will be presented by the Bureau, April 26–28, 1971. The seminar will cover the measurement methods used by the Bureau to establish and maintain the basic electrical units and to calibrate customers' standards of resistance, voltage, current, capacitance, inductance, and power from direct current up through 30 kHz. Voltage and current-ratio measurements will be included. The program will consist of lectures and demonstrations in the Electricity Division laboratories. Emphasis will be on measurement techniques that should be useful to workers in standards and calibration laboratories.

### Prerequisites

Candidates must have undergraduate college-level training in physics or electrical engineering and must be currently engaged in professional work in precise electrical measurements at a level involving the basic reference standards of a calibration or standards laboratory. Preference will be given to those whose position involves the training of others in precise electrical measurements.

### Arrangements

Attendance will be limited to 50 persons and, for laboratory demonstrations, each group will be divided into subgroups. Fee: $140. Apply to: R. F. Dziuba, Electricity Division, National Bureau of Standards, Washington, D.C. 20234 (Tel: 301–921–2727).




# STANDARDS AND CALIBRATION

## STANDARD FREQUENCY AND TIME BROADCASTS

High-frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. The NBS time scale, UTC(NBS), and the U.S. Naval Observatory time scale, UTC(USNO), are jointly coordinated to within ± 5 microseconds. The UTC pulses occur at intervals that are longer than one coordinate second by 300 parts in $10^{10}$ during 1971, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC

scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on 1 April 1971.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on 1 April 1971. The seconds pulses emitted from WWVB will be retarded 200 ms.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

# Simple, Dependable Electrical Feed Through for High Pressures

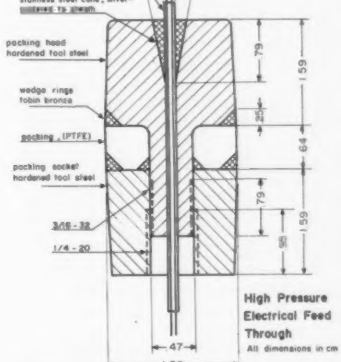
A NOVEL TYPE ELECTRICAL FEED THROUGH for use at high pressures has been developed[1] by P. L. M. Heydemann of the Heat Division. Featuring simplicity and reliability, the device has been operated without a single failure for more than 150 runs, many of which exceeded pressures of $2.5 \times 10^9$ N·m$^{-2}$ (25 kb). The feed through can be used for measurements with dc requiring very high insulation resistance as well as for rf up to 30 MHz.

The feed through consists basically of a stainless steel tube enclosing one to four leads in alumina insulation. A stainless steel cone with about a 16° taper is silver-soldered onto the tubing, greased with petroleum jelly or silicone grease, and hand pressed from the pressure side into a conical seat. The sheath near each end of the feed through is removed by electroetching to prevent nicking of the center conductors. Each end of the feed through is sealed by epoxy.

Feed throughs of this type have been used repeatedly at NBS to pressures of 27 kb. None of the feed throughs has ever failed, leaked pressure fluid noticeably, or reduced its electrical leakage resistance below several hundred megohms. Their insulation resistance of more than 2000 MΩ between the leads and the outside sheath makes them especially valuable for use with manganin or strain gages. Other feed throughs, based on the same fabrication principles, are used at frequencies up to 30 MHz for nuclear quadrupole and ultrasonic measurements.

[1] Heydemann, P. L. M., A simple and dependable electrical feed through for high pressures, Rev. Sci. Instr. 41, 12, 1896 (Dec. 1970).

*Photograph shows both an installed and uninstalled high-pressure electrical feed through. The can mounted on top of a Bridgman type unsupported area seal contains a manganin gage. Several jacks are mounted in the bakelike cover of the can for connection to apparatus in the pressure chamber.*




*Cross-sectional drawing of the high-pressure electrical feed through developed at NBS.*

# PUBLICATIONS of the National Bureau of Standards*

## PERIODICALS

*Technical News Bulletin*, Annual Subscription: Domestic, \$3; foreign, \$4. Single copy price 30 cents. Available on a 1-, 2-, or 3-year subscription basis. SD Catalog No. C13.13:55.

*Journal of Research of the National Bureau of Standards*

*Section A. Physics and Chemistry.* Issued six times a year. Annual subscription: Domestic, \$9.50; foreign, \$11.75. Single copy price varies. SD Catalog No. C13.22/sec.A:74.

*Section B. Mathematical Sciences.* Issued quarterly. Annual subscription: Domestic, \$5; foreign, \$6.25. Single copy, \$1.25. SD Catalog No. C13.22/sec.B:74.

*Section C. Engineering and Instrumentation.* Issued quarterly. Annual subscription: Domestic, \$5; foreign, \$6.25. Single copy, \$1.25. SD Catalog No. C13.22/sec.C:74.

## CURRENT ISSUES OF THE JOURNAL OF RESEARCH

J. Res. Nat. Bur. Stand. (U.S.), **75A2** (Phys. & Chem.) (March–April 1971), SD Catalog No. C13.22/sec.A:75/2.

Tentative set of key values for thermodynamics—Part I. Report of the ICSU-CODATA Task Group on Key Values for Thermodynamics, October, 1970. S. Sunner.

Expanded formulation of thermodynamic scaling in the critical region. Martin J. Cooper.

Table of spin-orbit energies for p-electrons in neutral atomic (core) np configurations. W. C. Martin.

Heat capacities of cis-1,4-polyisoprene from 2 to 360 K. S. S. Chang and A. B. Bestul.

Combined low-pressure and high-pressure measurements of density and bulk modulus of aviation instrument oil and 2-methylbutane and their mixtures. James C. Houck and Peter L. M. Heydemann.

Crystal structure of $Ca_2Na_2(CO_3)_3$ (shortite). B. Dickens, A. Hyman, and W. E. Brown.

Publications of the National Bureau of Standards.

J. Res. Nat. Bur. Stand. (U.S.), **75C1** (Eng. & Instr.) (January–March 1971), SD Catalog No. C13.22/sec.C:75/1.

Rotary-vane attenuator with an optical readout. W. E. Little, W. Larson, and B. J. Kinder.

Design and operational characteristics of a high-speed (millisecond) system for measurement of properties at high temperature. A. Cezairliyan.

New method of determining residual thiosulfate in processed photographic film. C. I. Pope.

Scanning densitometer for continuous recording of spectral transmission density at low spatial contrast. W. L. McLaughlin, M. Rosenstein, E. Hussmann, and J. J. Lantz, Jr.

Rotating optical attenuator for the generation of subsecond duration sawtooth shape radiance pulses. A. Cezairliyan.

Sound speed measurements in solids; absolute accuracy of an improved transient pulse method. T. M. Proctor, Jr.

Seismic response of infrasonic microphones. A. J. Bedard, Jr.

Publications of the National Bureau of Standards.

## OTHER NBS PUBLICATIONS

Blandford, J. M., Gurel, L. M., Fibers and fabrics, Nat. Bur. Stand. (U.S.), Consumer Info Series 1, 31 pages (Nov. 1970) 65 cents, SD Catalog No. C13.53:1.

Brenner, F. C. Tires. Their selection and care, Nat. Bur. Stand. (U.S.), Consumer Info. Series 2, 32 pages (Nov. 1970) 65 cents, SD Catalog No. C13.53:2.

Corliss, E. L. R., Hearing aids, Nat. Bur. Stand. (U.S.) Monogr. 117, 26 pages (Oct. 1970) 35 cents, SD Catalog No. C13.44:117.

Glass, A. J., Guenther, A. H., Editors, Damage in laser materials, Proceedings of a Symposium Sponsored by the American Society for Testing and Materials and by the National Bureau of Standards June 24–25, 1970, NBS, Boulder, Colorado, Nat. Bur. Stand. (U.S.), Spec. Publ. 341, 133 pages (Dec. 1970) \$1.25, SD Catalog No C13.10:341.

Jordan, R. H., Stark, M. C., Bunn, C. O., Donaldson, J. L., Obright, W. J., Millie, H. R., Gilsinn, J., Goldman, A. J., Horn, W. A., Systems analysis of inland consolidation centers for marine cargo, Nat. Bur. Stand. (U.S.), Tech. Note 530, 162 pages (Nov. 1970) \$1.25, SD Catalog No. C13.46:530.

LaFleur, P. D., Becker, D. A., Editors, Activation analysis section: Summary of activities, July 1969 to June 1970. Nat. Bur. Stand. (U.S.), Tech. Note 548, 164 pages (Dec. 1970) \$1.25, SD Catalog No. C13.46:548.

Marshall, R. D., Thom, H. C. S., Editors, Proceedings of technical meeting concerning wind loans on buildings and structures held at the National Bureau of Standards, Gaithersburg, Maryland, January 27–28, 1969, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 30, 172 pages (Nov. 1970) \$1.75, SD Catalog No. C13.29/2:30.

McSparron, D. A., Mohan, K., Raybold, R. C., Saunders, R. D., Zalewski, E. F., Spectroradiometry and conventional photometry and interlaboratory comparison, Nat. Bur. Stand. (U.S.), Tech. Note 559, 197 pages (Nov. 1970) \$1.50, SD Catalog No. C13.46:559.

Oberholtzer, B. L., Publications of the National Bureau of Standards 1968–1969, Nat. Bur. Stand. (U.S.), Spec. Publ. 305 Suppl. 1, 497 pages (December 1970) \$4.50, SD Catalog No. C13.10:305 Suppl.

Plitt, K. F., Adhesives for everyday use, Nat. Bur. Stand. (U.S.), Consumer Info. Series 3, 17 pages (Nov. 1970) 40 cents, SD Catalog No. C13.53:3.

White, H., Editor, Vocabulary for Information Processing, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB.) 11, 4 pages (1970) 15 cents, SD Catalog No. C13.52:11.

## PUBLICATIONS IN OTHER JOURNALS

*This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.*

Davis, D. D., Jespersen, J. L., Kamas, G., The use of television signals for time and frequency dissemination, Proc. IEEE **58,** No. 6, 931–933 (June 1970).

Diller, D. E., Hanley, H. J. M., Roder, H. M., The density and temperature dependence of the viscosity and thermal conductivity of dense simple fluids, Cryogenics **10,** No. 4, 286–294 (Aug. 1970).

Douglas, T. B., New approach for evaluating lattice-configurational thermodynamic properties, J. Chem. Phys. **51,** No. 7, 2831–2839 (Oct. 1969).

Engen, G. F., A new method of characterizing amplifier noise performance (Summary), Proc. Conf. on Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2–5, 1970, CPEM Digest, pp. 20–21 (1970).

Farrar, T. C., Pulsed and Fourier transform NMR spectroscopy, Anal. Chem. **42,** No. 4, 109A–112A (Apr. 1970).

Frederick, N. V., Scott, W. W., Jr., A simple technique for metalizing boron nitride, Rev. Sci. Instr. **40,** No. 9, 1240 (Sept. 1969).

Freeman, D. H., Zielinski, W. L., Jr., Rittner, W. F., Recognition of crosslinking in the infrared spectra of poly(styrene-divinylbenzene), Proc. Ion Exchange in the Process Industries Conf., Imperial College of Science and Technology, London, England, pp. 27–30 (1970).

Gebbie, H. A., Kuhn, P., Bohlander, R. A., Scattering by high cirrus: Its effect on submillimeter wave determinations of atmospheric water vapor, Nature, Letter to Editor, **226,** No. 5242, 71–72 (Apr. 1970).

Gibson, B. F., O'Connell, J. S., Angular distribution of the reaction $^1H(d,^3He)_\gamma$, Phys. Letters **32B,** No. 5, 331–332 (Aug. 1970).

Haar, L. Shenker, S. H., A phenomenological equation of state, Proc.. 5th Symp. on Thermophysical Properties, Boston, Mass., September 30–October 2, 1970, C. F. Bonilla, Ed., pp. 223–226 (American Society of Mechanical Engineers, New York, N.Y., 1970).

Halford, D., Frequency stability of quality quartz crystal oscillators: Performance and some critical applications, Proc. Intern. Colloq. Chronometrie, Paris, France, September 16–20, 1969, Serie A, pp. A-11-1–A-11-3 (Sept. 1969).

Hardy, S. C., Coriell, S. R., Morphological stability of ice cylinders in aqueous solution, J. Cryst. Growth **7**, No. 2, 147–154 (Sept.–Oct. 1970).

Hayward, E., Schwartz, R. B., Murray, K. M., Comments on isospin of the $B^{11}$ giant resonance, Phys. Rev. **2**, No. 2, 761–762 (Aug. 1970).

Hellwig, H., The hydrogen storage beam tube: A proposal for a new frequency standard, Metrologia **6**, No. 2, 56–60 (Apr. 1970).

Hellwig, H., Allan, D. W., Glaze, D. J., Vessot, R. F. C., Levine, M., Zitzewitz, P. W., Peters, H. E., Measurement of the unperturbed hydrogen hyperfine transition frequency (Summary), Proc. Conf. on Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2–5, 1970. CPEM Digest, pp. 72–73 (1970).

Hoer, C., Agy, D., A Broadhurst resistive coupler, Proc. Conf. on Precision Electromagnetic Measurements (Summary), National Bureau of Standards, Boulder, Colo., June 2–5, 1970, CPEM Digest, pp. 18–19 (1970).

Homan, D. N., Zapf, T. L., Two-stage guarded inductive voltage division for use at 100 kHz, Proc. 1969 Instrument Society of America Conf., Houston, Tex., October 27–30, 1969, pp. 69–614 (1969).

Hunt, C. M., Woolf, A. R., Comparison of some different methods for measuring particle size using microscopically calibrated glass beads, Powder Technol. **3**, 9–23 (1969).

Jennings, D. A., West, E. D., A laser power meter for large beams, Rev. Sci. Instr. **41**, No. 1, 565–567 (Apr. 1970).

Johannesen, R. B., Ferretti, J. A., Harris, R. K., UEAITR: A new computer program for analysis of NMR spectra analysis of the proton spectrum of triisopropylphosphine, J. Mag. Resonance **3**, No. 1. 84–93 (July 1970).

Kidnay, A. J., Hiza, M. J., Physical adsorption in cryogenic engineering, Cryogenics **10**, No. 4, 271–277 (Aug. 1970).

Krauss, M., Mies, F. H., Molecular-orbital calculation of the shape resonance in $N_2$, Phys. Rev. A **1**, No. 6, 1592–1598 (June 1970).

Lance, H. W., Report on metrology sessions at the 24th annual ISA conference, Appl. Opt. **9**, No. 6, 1497–1498 (June 1970).

Lesclaux, R., Searles, S., Sieck, L. W., Ausloos, P., Irradiation of cyclohexene with 8.4, 10.0 and 11.6–11.8 eV photons. Dissociation of neutral excited cyclohexene and reactions of $C_6H_{10}^+$, J. Chem. Phys. **53**, No. 8, 3336–43 (Oct. 1970).

Levin, E. M., Liquid immiscibility in oxide systems, Chapter in Phase Diagrams Materials Science and Technology, Volume 3. The Use of Phase Diagrams in Ceramics, Glass and Metal Technology, pp. 143–236, (Academic Press, Inc., New York, N.Y., 1970).

Levin, E. M., Roth, R. S., The system niobium pentoxide-phosphorus pentoxide, J. Solid State Chem. **2**, No. 2, 250–261 (1970).

Lias, S. G., Collin, G. J., Rebbert, R. E., Ausloos, P., Photolysis of ethane at 11.6–11.8 eV, J. Chem. Phys. **52**, No. 4, 1841–1851 (Feb. 1970).

Lias, S. G., Rebbert, R. E., Ausloos, P., Irradiation of xenon-propane and argon-propane mixtures with gamma rays and 21.2 eV photons, J. Chem. Phys. **52**, No. 2, 773–783 (Jan. 1970).

Madey, T. E., Yates, J. T., Jr., Chemisorption on single crystals: $H_2$ on (100) tungsten, Proc. Colloque Intern. sur la Structure et les Proprietes des Surfaces des Solides, Paris, France, July 7–11, 1969, No. 187, pp. 155–162 (Centre National de la Recherche Scientifique, Paris, France, 1970).

Margoshes, M., Schribner, B. F., Emission spectrometry, Anal. Chem. **42**, No. 5, 398R–417R (Apr. 1970).

Marvin, R. S., Rheological models and measurements (Proc. 5th Intern. Congress on Rheology, Kyoto, Japan, Oct. 7–11, 1968), Chapter in Fifth International Congress on Rheology, S. Onogi, Ed., **1**, 85–96 (University of Tokyo Press and University Park Press, Tokyo, Japan, 1969).

Marton, L., Survey of microanalysis-interpolation and extrapolation,, Chapter in Electron Probe Microanalysis, 1–14 (Academic Press Inc., New York, N.Y., 1969).

Mauvais, C. J., Latanison, R. M., Ruff, A. W., Jr., On the anisotropy observed during the passivation of nickel monocrystals, J. Electrochem. Soc. **117**, No. 7, 902–903 (July 1970).

Melmed, A. J., Carroll, J. J., Ellipsometry, LEED, and FEM study of evaporated epitaxial films of iron on (O11) tungsten, Surface Sci., Letters to the Editor **19**, No. 1, 243–248 (Jan. 1970).

Mighell, A. D., Reimann, C. W., Santoro, A., The crystal structure of the 2:1 dimer $[(\text{pyridine N-oxide})_2CuBr_2]_2$, Chem. Commun. **4**, 204 (1970).

Milligan, D. E., Jacox, M. E., Guillory, W. A., Infrared specrum of $NO_2$-ion isolated in an argon matrix, J. Chem. Phys. **52**, No. 8, 3864–3868 (Apr. 1970).

Molino, J. A., Noise: The growing hazard, Dialog **1**, No. 4, 26–28 (1970).

Mountain, R. D., Comments on fluctuation theory calculations of the specific heat near the critical point, J. Chem. Phys. **52**, No. 7, 3852–3853 (Apr. 1970).

Mountain, R. D., Liquids: Dynamics of liquid structure, Critical Reviews in Solid State Sciences **1**, No. 1, 5–46 (Chemical Rubber Co., Cleveland, Ohio, Mar. 1970).

Negas, T., Roth, R. S., The system $SrMnO_{3-x}$, J. Solid State Chem. **1**, 409–418 (1970).

Olver, F. W. J., Why steepest descents?, SIAM Rev., **12**, No. 2, 228–247 (Apr. 1970).

Osgood, C. F., A method in diophantine approximation (III), Acta Arithmetica **XVI**, 5–22 (1969).

Osgood, C. F., A method in diophantine approximation (IV), Acta Arithmetica **XVI**, 23–40 (1969).

Page, C. H., Relations among systems of electromagnetic equations, Am. J. Phys. **38**, No. 4, 421–424 (Apr. 1970).

Page, C. H., The trolley problem, Am. J. Phys. **38**, No. 5, 608–610 (May 1970).

Parke, W. C., Ponzini, R. G., Williams, H. T., Remarks on finite-energy sum rules, Phys. Rev. **1**, No. 1-D, 134–139 (Jan. 1970).

Paulsen, P. J., Alvarez, R., Mueller, C. W., Spark source mass spectrographic analysis of ingot iron for silver, copper, molybdenum and nickel by isotope dilution and for cobalt by an internal standard technique, Anal. Chem. **42**, 673–675 (May 1970).

Pfeiffer, E. R., Schooley, J. F., Effect of stress on the superconducting transition temperature of $SrTiO_3$, J. Low Temp. Phys. 2, No. 3/4, 333–352 (Aug. 1970).

Phillips, S. L., Johnson, C. E., Effect of atmospheric exposure on the contact resistance of selected tin alloys, J. Electrochem. Soc. **117**, No. 6, 827–830 (June 1970).

Qureshi, I. H., McClendon, L. T., LaFleur, P. D., Extraction studies of the group IIIB–VIIB elements and the lanthanides utilizing bis(2-ethyl-hexyl) orthophosphoric acid, Radiochim. Acta. **12**, No. 2, 107–111 (Aug. 1969)

Randall, E. B., Jr., Lashof, T. W., An interlaboratory study of the measurement of the bursting strength of paper, Tappi **53**, No. 5, 799–809 (May 1970).

Raveche, H. J., Mayer, J. E., Theory of diffusion in simple liquid mixtures, J. Chem. Phys. **52**, No. 8, 3990–4004 (Apr. 1970).

Reed, R. P., Durcholz, R. L., Cryostat and strain measurement for tensile tests to 1.5 °K (Proc. 1969 Cryogenic Engineering Conf., June 16–18, 1969, Univ. of California, Los Angeles), Chapter in Advances in Cryogenic Engineering 15, Paper No. D-3, 109–116 (Plenum Press, Inc., New York, N.Y., 1970).

Robertson, A. F., Gross, D., Fire load, fire severity, and fire endurance, ASTM Spec. Tech. Publ. 464, Fire Test Performance, pp. 3–29 (Jan. 1970).

Rockett, J. A., Objectives and pitfalls in the simulation of building fires with a computer, Fire Tech. **5**, No. 4, 311–322 (Nov. 1969).

Rosenblatt, J. R., Joiner, B. L., Hogben, D., OMNITAB-Rapid statistical manipulation (Proc. Conf. Small-Area Statistics, American Statistical Association, New York, N.Y., Aug. 21, 1969). Paper in Census Tract Papers Final 1970 Census Plans and Four Programing Systems for Computerized Data Retrieval and Manipulation, Series GE-40, No. 6, 46–59 (Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, 65 cents, 1970).

Ryan, J. V., Implementation of the Flam-

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mable Fabrics Act, Proc. Conf. Flame Retardant Cotton Batting Workshop, New Orleans, La., Nov. 15, 1968, ARS 72-72, 1–77 (Oct. 1969).

Searles, S. K., Sieck, L. W., High pressure photoionization mass spectrometry, III. Reactions of $NO^+(X' \Sigma^+)$ with $C_3$-$C_7$ hydrocarbons at thermal kinetic energies, J. Chem. Phys. **53,** No. 2, 794–797 (July 1970).

Searles, S. K., Sieck, L. W., Ausloos, P., Reactions of $C_2H_6^+$. Formation of the $(C_2H_6)_2^+$ ion, J. Chem. Phys. **53,** No. 2, 849–850 (July 1970).

Shinyayev, A. Y., Butrymowicz, D. B., Interdiffusion in and the phase diagram for vanadium-rich alloys of the V–Al system at pressures 0 to 47 kbar, Met. Trans. **1,** No. 7, 1905–1907 (July 1970).

Shipp, W. E., Surface tension of binary mixtures of several organic liquids at 25 °C, J. Chem. Eng. Data **15,** No. 2, 308–311 (Apr. 1970).

Simson, B. G., Mandel, J., Brenner, F. C., Research for a uniform quality grading system for tires. III. Breaking energy, Rubber Chem. Tech. **43,** No. 2, 356–369 (Mar. 1970).

Sindt, C. F., Ludtke, P. R., Slush hydrogen flow characteristics and solid fraction upgrading (Proc. 1969 Cryogenic Engineering Conf., June 16–18, 1969, Univ. of California, Los Angeles), Chapter in Advances in Cryogenic Engineering 15, Paper No. I-6, 382–390 (Plenum Press, Inc., New York, N.Y., 1970).

Smith, S. J., Survey on electron-atom collision experiments (Proc. Sommerfeld Centennial Memorial Meeting, Munich, Germany, Sept. 9–14, 1968), Chapter in Physics of the One- and Two-Electron Atoms, F. Bopp and H. Kleinpoppen, ed., 574–597 (North Holland Publ. Co., Amsterdam, The Netherlands, 1969).

Snyder, N. S., Heat transport through helium II: Kapitza conductance, Cryogenics **10,** No. 2, 89–95 (Apr. 1970).

Steward, W. G., Smith, R. V., Brennan, J. A., Cooldown transients in cryogenic transfer lines (Proc. 1969 Cryogenic Engineering Conf., June 16–18, 1969, Univ. of California, Los Angeles), Chapter in Advances in Cryogenic Engineering 15, Paper No. I-2, 354–363 (Plenum Press, Inc., New York, N.Y., 1970).

Stief, L. J., Payne, W. A., DeCarlo, V. J., Gorden, R., Jr., Ausloos, P., Comment on "Xenon sensitized photolysis of carbon dioxide," J. Chem. Phys. **53,** No. 1, 475–476 (July 1970).

Straty, G. C., Prydz, R., Melting curve and triple-point properties of fluorine, Phys. Letters **31A,** No. 6, 301–302 (Mar. 1970).

Straty, G. D., Prydz, R., The vapor pressure of liquid fluorine (Proc. 1969 Cryogenic Engineering Conf., June 16–18, 1969, Univ. of California, Los Angeles), Chapter in Advances in Cryogenic Engineering 15, Paper No. B–1, 36–41 (Plenum Press, Inc., New York, N.Y., 1970).

Sugar, J., Configuration $4f^{13}5d$ of doubly ionized ytterbium, J. Opt. Soc. Am. **60,** No. 4, 571–572 (Apr. 1970).

Sugar, J., Spectrum of doubly ionized thulium (Tm III), J. Opt. Soc. Am. **69,** No. 4, 454–466 (Apr. 1970).

Swartzendruber, L. J., Bennett, L. H., Clustering, cold work, and the Mössbauer effect doublet structure in Cu-Ni-Fe alloys, Phys. Letters **31A,** No. 10, 581–582 (May 1970).

Tighe, N. J., Hockey, B. J., Ion thinning of electron microscope specimens (Proc. 10th Symp. Electron, Ion, and Laser Beam Technology, May 21–23, 1969, National Bureau of Standards, Gaithersburg, Md.), Record of 10th Symposium on Electron, Ion, and Laser Beam Technology, L. Marton, ed., pp. 375–380 (San Francisco Press Inc., San Francisco, Calif., 1970).

Torrance, K. E., Orloff, L., Rockett, J. A., Numerical study of natural convection in an enclosure with localized heating from below—Creeping flow to the onset of laminar instability, J. Fluid Mech. **36,** Part I, 33–54 (1969).

Torrance, K. E., Orloff, L., Rockett, J. A., Experiments on natural convection in enclosures with localized heating from below, J. Fluid Mech. **36,** Part I, 21–31 (1969).

Verdier, P. H., Relaxation behavior of the freely jointed chain, J. Chem. Phys. **52,** No. 11, 5512–5517 (June 1970).

Vicentini-Missoni, M., Joseph, R. I., Green, M. S., Sengers, J. M. H. L., Scaled equation of state and critical exponents in magnets and fluids, Phys. Rev. B. **1,** No. 5, 2312–2331 (Mar. 1970).

Weber, L. A., The P-V-T surface of oxygen in the critical region; densities of saturated liquid and vapor (Proc. 1969 Cryogenic Engineering Conf., June 16–18, 1969, Univ. of California, Los Angeles), Chapter in Advances in Cryogenic Engineering 15, Paper No. B–4, 50–57 (Plenum Press, Inc., New York, N.Y., 1970).

Weisman, H. M., In the beginning was the word—information needs and uses in science and technology, Paper E 4-2 in Proceedings of the Seventeenth International Technical Communications Conference, Minneapolis, Minn., June 3–6, 1970, B. F. Hylen and R. R. McDaniel, ed., 1–5 (Society of Technical Writers and Publishers Inc., 1010 Vermont Ave., N.W., Washington, D.C. 20005, 1970).

Winogradoff, N. N., Neill, A. H., Jr., Temperature dependence of the power output of the spontaneous emission from GaAs laser diodes, Intern. J. Electron. **28,** No. 5, 401–406 (1970).

Winogradoff, N. N., Neill, A. H., Petrescu-Prahova, J. B., Band tailing and the spontaneous spectra of compensated epitaxial GaAs laser junctions, IEEE J. Quantum Electron. **QE–6,** No. 6, 305–310 (June 1970).

Wolfe, W. C., Performance tests for floor coverings, Mater. Res. Stand. **10,** No. 7, 15–18 (July 1970).

Wood, L. A., Creep of "pure-gum" vulcanisates of natural rubber, (Proc. Intern. Natural Rubber Conf., Kuala Lumpur, Malaya, Sept. 1968), J. Rubber Inst. Malaya **22,** No. 3, 309–316 (1969).

Wood, L. A., Shouse, P. J., Passaglia, E., How just appreciable fading of AATCC L-4 wool standard is related to exposure time, Textile Chem. Colorist **2,** No. 11, 182–190 (June 1970).

Yakowitz, H., Comments on "application of color photography to electron microbeam probe samples", Rev. Sci. Instr. **41,** No. 4, 601 (Apr. 1970).

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